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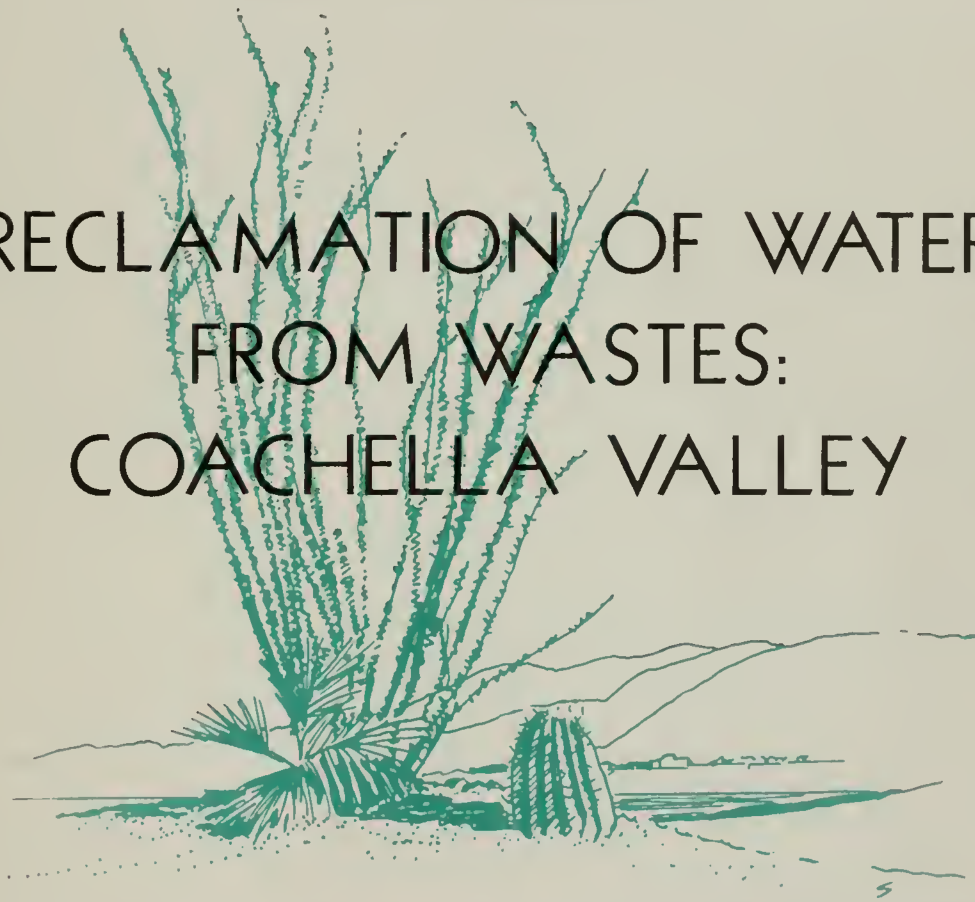
BULLETIN No. 80-3

RECLAMATION OF WATER FROM WASTES: COACHELLA VALLEY



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DECEMBER 1966

HUGO FISHER	EDMUND G. BROWN	WILLIAM E. WARNE
Administrator	*Governor*	*Director*
The Resources Agency	State of California	Department of Water Resources

A major potential use of reclaimed waste water
in Coachella Valley is irrigation of golf courses.

State of California
THE RESOURCES AGENCY
Department of Water Resources

BULLETIN No. 80-3

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State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

ENGINEERING CERTIFICATION

This report has been prepared under my direction as the professional engineer in direct responsible charge of the work, in accordance with the provisions of the Civil and Professional Engineers' Act of the State of California.

Ronald G. Hansen
Registered Civil Engineer

Registration No. C 11914

Date 10-19-1966

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District Engineer
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Date DEC 1 1966

Alfred R. Golzé
Chief Engineer

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Date DEC 2 1966

FOREWORD

Bulletin No. 80-3, "Reclamation of Water From Wastes: Coachella Valley", reports on an investigation conducted in accordance with Section 230 of the State Water Code which provides that the Department of Water Resources "shall conduct surveys and investigations relating to the reclamation of water from sewage and industrial wastes for beneficial purposes ...."

This is the third in a series of such studies to be published in the Bulletin No. 80 series. The first of these investigations was regarding the reclamation of wastes in the metropolitan Los Angeles area and the second on coastal San Diego County.

Contributions of information used in this investigation are gratefully acknowledged. Special mention is made of the cooperation of the following: Coachella Valley County Water District, City of Banning, Coachella Sanitary District, Indio Sanitary District, Mecca Sanitary District, Palm City Water Company, City of Palm Springs Department of Public Works, and Thermal Sanitary District.

William E. Warne
William E. Warne, Director
Department of Water Resources
The Resources Agency
State of California
December 12, 1966

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State of California
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DEPARTMENT OF WATER RESOURCES

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WILLIAM F. WARNE, Director, Department of Water Resources
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WILLIAM M. CARAH
Executive Secretary

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Engineer

ABSTRACT

Coachella Valley, located in central Riverside County, extends northwest from the Salton Sea approximately 65 miles. It encompasses approximately 375,000 acres of land that drains via the Whitewater River system into the Sea. At the time of the study (1962-63), 23 percent of the waste water of domestic origin and virtually all that of agricultural origin were being wasted to the Sea. / Mineral analyses of domestic waste waters show them to be of a generally high quality. Predictions are that domestic waste water will increase to 29,000 acre-feet per year by 1970. / Major water supplies are ground water and imported Colorado River water. Use exceeds the mean annual supply and an overdraft of 100,000 acre-feet per year exists. In the future, water will be imported from the State Water Project, amounting to a maximum of 68,000 acre-feet by 1990. / Forecasts are that irrigated agriculture will increase to about 88,000 acres by 1990, and total agricultural consumptive use of water will be 298,900 acre-feet per year. By 1990, population will have increased to 271,000 persons requiring 91,000 acre-feet of water per year. / The study shows that, from the standpoint of supply and demand, quality, economic factors, and legal requirements, reclamation of water from domestic wastes in Coachella Valley is feasible. Therefore, reclaimed waste water can be considered an economical, suitable supplemental supply to be used for irrigating golf courses and other recreational facilities. Its use would reduce the overdraft of ground water. / Recommendations are: waste water reclamation in Coachella Valley be continued as a means of conserving the water supply; as supplies of good quality waste water increase in the future, consideration be given to using these supplies rather than wasting them to the Salton Sea; and consideration of reclamation as a means of disposing of waste water be included in future water and sewerage studies. / Foldout plates show location of water sampling points, waste water disposal systems, present and proposed waste water reclamation plants, and present and proposed uses.

CHAPTER I. INTRODUCTION

Increasing population and agricultural growth in the Coachella Valley of Riverside County in Southern California have caused attention to be directed to possible additional sources of water. Coachella Valley is not blessed with sufficient local surface and ground water supplies to satisfy present water demands; water shortages must be met by importations from the Colorado River and in the future, from the State Water Project. Imported water from the Colorado River is limited, and future supplies from the State Water Project will be relatively expensive compared with reclaimed waste water. The reclamation of water from wastes is a process whereby used water that would otherwise be wasted is reclaimed for additional beneficial uses. Thus, reclaimed waste water can be considered a supplemental supply for Coachella Valley to be used for lower quality uses, such as irrigation, while more expensive water from the State Water Project would be reserved for higher quality domestic uses.

In Coachella Valley, the Salton Sea -- a highly saline inland sea with mineral characteristics similar to those of the ocean -- is a catch basin for all water wasted from the valley. It also receives waste water from the heavily irrigated Imperial Valley to the south. The waste waters from the two valleys have been more than enough to sustain the level of the Salton Sea for recreational purposes. In recent years, the gradually rising level of the sea has been causing some threat to the surrounding low-lying lands.

At the time of the study, 1962-1963, 23 percent of the waste water of domestic origin from Coachella Valley (1,234 acre-feet per year), and virtually all of that of agricultural origin were being wasted to the

Salton Sea. Industrial waste* flows in Coachella Valley are minor and can be ignored for the purposes of this report.

Thus, 77 percent of the waste water of domestic origin in the Coachella Valley (4,131 acre-feet per year) is already being reclaimed and used beneficially.

As the population of the valley grows -- as forecasts show it will -- the amount of domestic waste water available will increase. Predictions are that the total domestic waste water discharged in the Coachella Valley will increase from the present 5,365 acre-feet per year to about 29,000 acre-feet per year by 19~~70~~90, a substantial potential supplemental water supply.

Objective and Scope of Investigation

In conducting this investigation, the Department's objective has been to determine the feasibility of the continued and increased reclamation of waste water in Coachella Valley.

Such a study is in line with the request of the Coachella Valley Advisory Planning Committee "to determine the maximum usage of all available water in the Coachella Valley ...." (A copy of the resolution passed by the Committee and the accompanying letter of May 27, 1963, are contained in Appendix D.)

To attain the stated objective, the investigators collected and analyzed basic information in the following four categories:

1. Water requirements and supply,
2. Quantity and quality of water that can be reclaimed from waste water presently being discharged to the Salton Sea from Coachella Valley,

---

*Definitions of words or special terms used in this report are given in Appendix B.

LOOKING SOUTH
TOWARD SANTA ROSA MOUNTAINS

Rugged relief and extreme climatic conditions
typify Coachella Valley

3. Possible beneficial uses for reclaimed water,

4. Costs of reclaimed water.

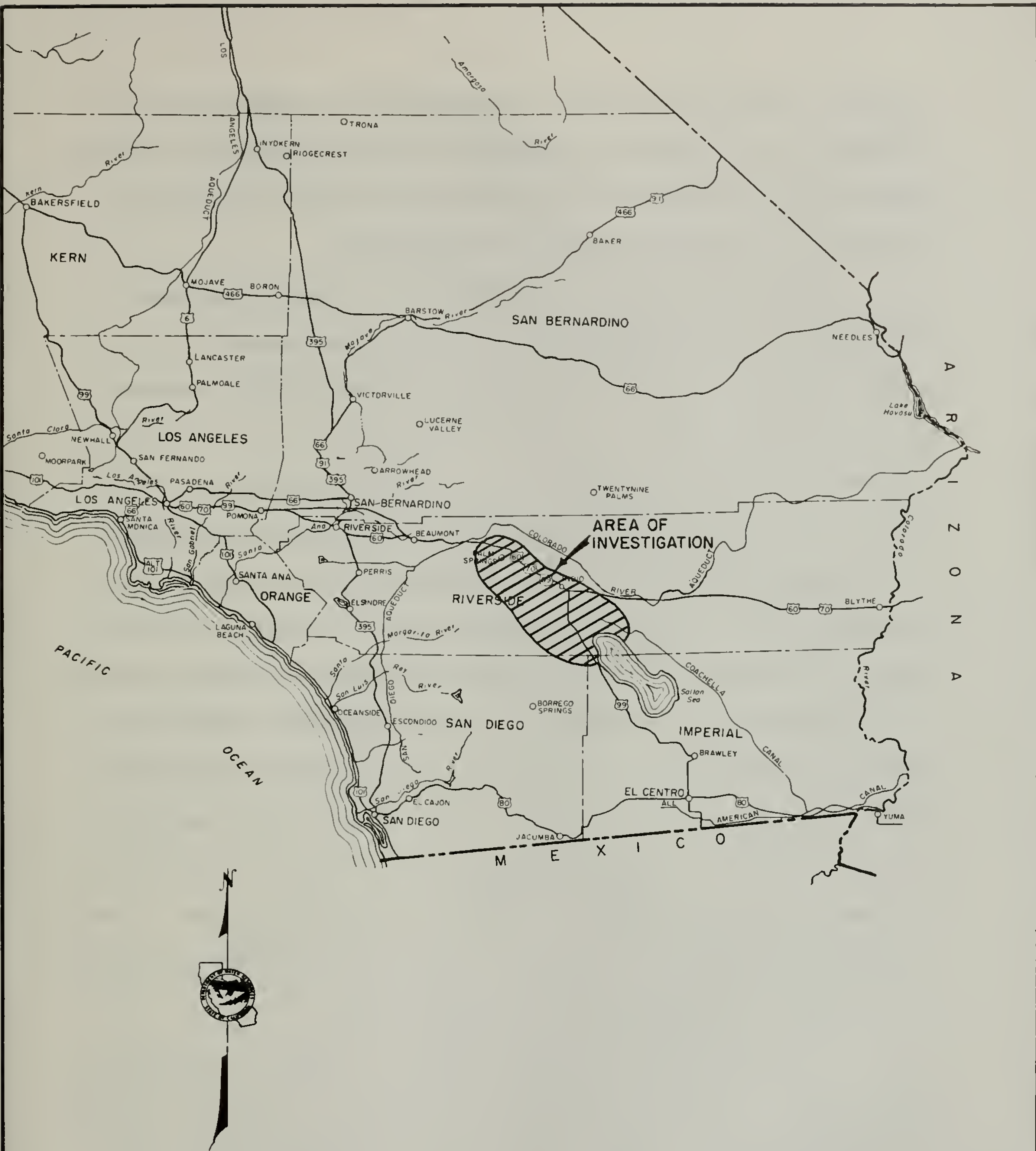
The results of the investigation are presented in this report generally in accordance with this outline, followed by a discussion of existing and potential waste water reclamation projects and conclusions and recommendations.

Area of Investigation

The area of investigation is generally called Coachella Valley, and is shown on Figure 1. It is located in central Riverside County, extending from the Salton Sea approximately 65 miles in a northwesterly direction. As is shown on Plate 1, Coachella Valley is bounded on the north by the San Bernardino and Little San Bernardino Mountains, on the east by the Little San Bernardino Mountains and Mecca Hills, on the south by the Salton Sea, and on the southwest and west by the Santa Rosa and San Jacinto Mountains. Separating the San Bernardino and San Jacinto Ranges is the San Gorgonio Pass, which is included in this investigation and report as a part of Coachella Valley. The study area encompasses approximately 375,000 acres of arid land with drainage in a southeasterly direction via the Whitewater River system to the Salton Sea, a saline body of water separated from the Gulf of California by the delta of the Colorado River.

Rugged relief and extreme climatic conditions typify Coachella Valley. Elevations range from more than 10,000 feet above sea level in the surrounding mountains to approximately 230 feet below sea level at the Salton Sea. Temperatures in the valley are typical of desert climates, ranging from well above 100 degrees Fahrenheit in summer to below freezing

FIGURE 1



STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT

RECLAMATION OF WATER FROM WASTES
IN COACHELLA VALLEY

VICINITY MAP

SCALE OF MILES
20 0 20 40 60

1965

in winter. Rainfall on the valley floor amounts to an annual average of less than 5 inches. Because precipitation contributes very little to the water resources of the area, ground waters are dependent upon surface runoff from surrounding mountains for replenishment.

Geologic formations of the study area, grouped according to ground water storage characteristics, fall into three categories: nonwater-bearing, semiwater-bearing, and water-bearing(13)*. Nonwater-bearing formations consist of crystalline rocks, which form the surrounding mountain ranges and underlie the basin at depth, and consolidated sediments of the basin. Semiwater-bearing formations consist of semiconsolidated sediments of low permeability. These are exposed in the series of low hills along the northeast side of the valley. Water-bearing formations, which occur extensively throughout the valley, consist of unconsolidated alluvial deposits. These water-bearing materials are present to depths that exceed 1,000 feet. In the southeastern portion of the valley are two aquifers separated by a zone of low permeability material. Capping the upper aquifer is a layer of tight clays and silts, with some sand, which contains water under semiperched conditions. These water-bearing zones constitute the principal reservoirs from which domestic water supplies in that part of the valley are drawn.

There are at present nearly 71,000 acres devoted to agriculture in the valley. The major agricultural activity is in citrus, truck crops, vineyards, and dates. Alfalfa, cotton, nuts, field crops, grains, and pasture land are also cultivated. The sale of these crops to the Los Angeles market represents a major source of income for the study area.

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*Numbers in parentheses indicate references listed in Appendix A.

The area of investigation has a year-long population of about 70,000 with two-thirds of the people living in urban areas. The major urban areas are Palm Springs, Indio, Banning, and Coachella. Palm Springs and its environs constitute one of the most popular winter resort areas in Southern California. During the cooler months and weekends throughout the year, thousands of tourists and people with desert homes visit Coachella Valley. Major highways from Los Angeles to Phoenix and Yuma cross the valley.

Within the study area, the treatment and disposal of wastes in sewered areas are accomplished by several sewage treatment plants with effluent disposal to the Whitewater River. In smaller communities, waste treatment is commonly handled by individual septic tanks and cesspools with disposal by seepage to the ground water basin. Major waste water treatment facilities are operated by seven communities in the area of investigation: Banning, Coachella, Indio, Mecca, Palm City, Palm Springs, and Thermal. A discussion of these facilities is included in Chapter III.

Prior Investigations and Reports

Reclamation of waste water has been studied by the Department of Water Resources over a number of years. In a series of initial investigations, the feasibility of waste water reclamation was studied on a statewide basis. These investigations were reported in four reports published in December 1952, June 1954, January 1958, and October 1963 under the title "Reclamation of Water from Sewage and Industrial Wastes in California"[4,5,6,12]. Later investigations have been concentrated on the feasibility of waste water reclamation in specific areas[9,14]. This bulletin is included in this latter series.

In 1964, the Department of Water Resources published a report entitled "Coachella Valley Investigation", Bulletin No. 108. This bulletin describes the boundaries of the ground water basins, and the geology, hydrology, water quality, and ground water storage capacity of the study area.

CHAPTER II. WATER REQUIREMENTS AND SUPPLY

Agricultural and urban growth in Coachella Valley is almost entirely dependent upon water supplied from the ground water basin and the Colorado River. The first development of ground water in the area occurred around 1900 with the drilling of wells to supply water for domestic and irrigation purposes. Since that time, ground waters have been utilized extensively and, since 1948, they have been supplemented by imported Colorado River water to meet the large irrigation demand. Imported water will be needed from the State Water Project or some other source to meet the future urban water requirements. A discussion of water requirements and supply follows.

Water Requirements

Water is required for the following beneficial uses in the study area: domestic consumption; light industry; and irrigation of agricultural lands, golf courses, and parks. These uses can be grouped under the headings of irrigation water requirements and urban water requirements, as is done in the following discussion.

Irrigation Water Requirements

A summary of agricultural land use in the study area[(10,11,13)*], both present and future, is presented in Table 1. At present (1962-63), there are nearly 71,000 acres devoted to irrigated agriculture. Projected to the year 1990, irrigated agricultural use should increase by about one-fourth to 88,000 acres. In 1962-63, golf courses covered about 2,000 acres in Coachella Valley.

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*Numbers in parentheses indicate references listed in Appendix A.

TABLE 1

PRESENT AND PROJECTED AGRICULTURAL LAND USE
IN COACHELLA VALLEY*

In acres

Crop	1960	1970	1980	1990
Alfalfa	5,900	5,900	5,900	5,900
Cotton	5,700	6,000	6,500	6,800
Citrus	12,100	19,100	22,500	24,700
Dates	5,200	4,700	4,000	3,200
Deciduous fruits and nuts	300	240	220	200
Truck crops	12,700	15,700	17,300	18,000
Field crops and grains	6,700	6,700	6,700	6,700
Pasture	2,800	2,800	2,800	2,800
Vineyards	13,100	16,400	18,200	19,900
TOTAL	64,500	77,540	84,120	88,200

*Adapted from Department of Water Resources Bulletin No. 108, Table 16, page 122, and Bulletin No. 119-3, Table 7, page 34.

Present and future consumptive use for irrigated agriculture in Coachella Valley are shown in Table 2. These are based on values of unit consumptive use presented in Table 2 and corresponding acreages presented in Table 1.

The value of unit consumptive use for golf course irrigation in Coachella Valley is approximately 5 feet per year. This unit requirement is somewhat less in the vicinity of San Gorgonio Pass.

Monthly requirements for all irrigation purposes vary as shown in Table 3. These values are based on records of imports from the Colorado River to Coachella Valley from July 1960 to June 1963. This information is used in later portions of the report in discussing the irrigation demand and for reclaimed water.

TABLE 2

PRESENT AND PROJECTED AGRICULTURAL CONSUMPTIVE USE
IN COACHELLA VALLEY

Crop	Unit consumptive use, in feet per year*	Consumptive use, in acre-feet			
		1960	1970	1980	1990
Alfalfa	5.0	29,500	29,500	29,500	29,500
Cotton	2.7	15,400	16,200	17,600	18,400
Citrus	3.9	47,200	74,500	87,800	96,300
Dates	5.0	26,000	23,500	20,000	16,000
Deciduous fruits and nuts	2.4	720	600	500	500
Truck crops	2.5	31,800	39,300	43,300	45,000
Field crops and grains	3.6	24,100	24,100	24,100	24,100
Pasture	4.8	13,400	13,400	13,400	13,400
Vineyards	2.8	36,700	45,900	51,000	55,700
TOTAL		224,800	267,000	287,200	298,900

*Adapted from Department of Water Resources Bulletin No. 108, Table 17, page 124.

TABLE 3

MONTHLY REQUIREMENTS FOR IRRIGATION WATER AS
PERCENTAGE OF TOTAL ANNUAL DEMAND

Month	Percent of total annual irrigation demand
January	5.3
February	5.5
March	8.1
April	9.8
May	11.8
June	11.3
July	12.4
August	12.5
September	9.9
October	6.1
November	3.9
December	3.4
TOTAL	100.0

Urban Water Requirements

In 1962-63, about 19,000 acres in Coachella Valley were devoted to urban use. The area of urban use is expected to expand to over 54,000 acres in 1990.

The population of Coachella Valley has increased substantially in the past decade. The primary centers of this increase in population are the resort and retirement communities and the industries that have grown in the area. Historical and projected populations of the study area are presented in Table 4.

TABLE 4

HISTORICAL AND PROJECTED POPULATIONS OF EXISTING COMMUNITIES AND URBAN AREAS OF COACHELLA VALLEY*

Area or community	1940	1950	1960	1970	1980	1990
Banning	3,900	7,000	10,300	14,100	18,900	24,800
Cabazon	0	0	500	1,000	1,600	2,200
Cathedral City	200	400	1,900	3,500	5,900	9,800
Coachella	700	2,800	4,900	8,000	13,000	20,000
Desert Hot Springs	100	500	1,500	3,200	6,600	12,900
Indio	2,300	5,300	9,700	17,000	29,000	49,000
North Palm Springs	100	300	800	1,800	3,700	7,200
Palm Desert	400	700	1,300	2,500	6,000	14,000
Palm Springs	3,400	7,700	13,500	27,500	45,000	69,000
Miscellaneous urban areas**	1,000	2,000	3,000	5,000	8,000	12,000
Total urban	12,100	26,700	47,400	83,600	137,700	220,900
Nonurban	4,900	9,800	20,800	27,100	35,300	50,100
TOTAL POPULATION	17,000	36,500	68,200	110,700	173,000	271,000

*Adapted from Department of Water Resources Bulletin No. 119-3, Table 5, page 28.
**Includes communities of La Quinta, Oasis, Thermal, Thousand Palms, and Mecca.

Estimated present and projected water requirements for the study area, including urban, are summarized in Table 5. The urban requirements were obtained by multiplying the population figures of Table 4 by an average use of 0.336 acre-foot per capita per year.[13]

TABLE 5

SUMMARY OF PRESENT AND PROJECTED WATER REQUIREMENTS
FOR COACHELLA VALLEY

In acre-feet

Type of use	1960	1970	1980	1990
Agriculture*	449,600	534,000	574,200	598,000
Golf courses	9,000	12,500	15,000	17,500
Urban	22,900	37,200	58,100	91,100
TOTALS	481,500	583,700	647,300	706,600

*Applied water is estimated to be two times consumptive use for salt balance.

Water Supply

Water is presently supplied to Coachella Valley from two major sources -- the Colorado River and the ground water basin -- with small amounts from waste water reclamation and negligible amounts from surface water. Plans for the future call for the addition of supplies from Northern California via the State Water Project, as well as continued use of present sources.

Present Supplies

The following discussion deals with each of the present sources of water supply in Coachella Valley: Colorado River, local ground water basin, waste water reclamation, and surface water.

Colorado River Water. Imported Colorado River water has been supplied to Coachella Valley since 1948 by the Coachella Valley County Water District. The District transports Colorado River water to the southern part of the valley via the Coachella Branch of the All-American

Canal. This water, comprising approximately 65 percent of the total water used in the valley, is utilized exclusively for irrigation purposes.

Quantities of imported water delivered each season to the valley are listed in Table 6. Total water delivered, approximately 340,000 acre-feet per season, has remained relatively constant since 1953-54 in spite of the steady growth of irrigated agriculture. This is because of the increased efficiencies in distribution and application of imported water, and because of increased extractions of local ground waters.

TABLE 6

SEASONAL IMPORTS OF COLORADO RIVER WATER
TO COACHELLA VALLEY*

In acre-feet

Season	Import**
1948-49	28,400
1949-50	95,800
1950-51	230,700
1951-52	301,100
1952-53	298,800
1953-54	338,700
1954-55	356,100
1955-56	367,300
1956-57	331,000
1957-58	324,300
1958-59	345,100
1959-60	333,100
1960-61	345,300
1961-62	348,300
1962-63	359,200

*Adapted from Department of Water Resources Bulletin No. 108, Table 14, page 114.
**Total import based on periodic measurement by the Coachella Valley County Water District.

The quantity of Colorado River water available to the valley is limited due to a recent U. S. Supreme Court decree which restricted the

Coachella Branch of All-American Canal

amount of water that California can take from the river and due to periodic shortages in the river. Even if more water from sources outside the Colorado River Basin were imported, the capacity of existing facilities would restrict importations.

Ground Water. In 1958, Department studies disclosed that about 32 percent, or 151,800 acre-feet, of the total water demand in the valley was supplied by ground water extraction(10,11,13). Of the total extracted, approximately 9 percent, or 13,900 acre-feet, satisfied urban water requirements, and the rest was used for irrigation. Estimates of safe yields from local ground water in the upper part of the basin are shown in Table 7.

TABLE 7

ESTIMATED SAFE YIELD OF LOCAL GROUND WATER[a]

Water agency	Year	Local ground water supply, in acre-feet per year
Coachella Valley County Water District	1960	3,800
	1970	5,000
	1980	5,000
	1990	5,000
Desert Water Agency[b]	1960	9,600
	1970	11,100
	1980	11,000
	1990	11,000
North Palm Springs County Water District	1960	200
	1970	500
	1980	1,200
	1990	1,200
San Gorgonio Pass Water Agency[c]	1960	5,800
	1970	5,800
	1980	5,000
	1990	4,000

a. Adapted from Department of Water Resources Bulletin 119-3, Table 15, page 53.
b. Includes Desert Hot Springs County Water District.
c. Includes Beaumont and small nonurban area east of Banning not in study area of this report.

The 1958 studies also indicated an average seasonal overdraft of usable ground water in the Coachella Valley Ground Water Basin of about 100,000 acre-feet. Water levels in the upper part of the Basin have been declining since 1935. Water levels since 1951 in the lower part of the Basin (semiperched ground water table) have been rising due to the application of imported water.

<u>Surface Water</u>. The quantity of surface inflow used as surface supply to the Valley floor is very small and can be considered negligible for the purposes of this portion of the report.

<u>Reclaimed Waste Water</u>. As has been pointed out earlier, the water requirements for Coachella Valley are being met at the expense of a 100,000-acre-foot annual overdraft of the ground water basin. About 1 percent of the total water requirement is being supplied by use of reclaimed waste water. Treated effluents are being reclaimed and used for irrigation of golf courses and farmlands, and for ground water recharge. Added plants for reclaiming even more water could be built to relieve a larger portion of the ground water overdraft.

Reclamation of water from wastes will be discussed in detail in subsequent chapters.

Future Supplies

In 1972, a major source of supplemental water will be available to the northern portions of Coachella Valley. Contracts have been completed with the State of California that provide for a supply from the State Water Project amounting to a maximum 68,000 acre-feet per year in 1990. Projected demands for this water for these water agencies are presented in Table 8. By 1990, these agencies will require at least 65,000 acre-feet per year.

TABLE 8

DEMAND FOR WATER FROM THE
STATE WATER PROJECT IN COACHELLA VALLEY[11]

Water agency	Demand, in acre-feet		
	1972	1980	1990
Coachella Valley County Water District	4,900	10,000	20,000
Desert Water Agency*	7,800	16,000	33,000
San Gorgonio Pass Water Agency**	3,600	7,000	12,000
TOTAL	16,300	33,000	65,000

*Includes North Palm Springs and Desert Hot Springs County Water Districts.
**Includes Beaumont and small nonurban area east of Banning not in study area.

In addition, some of the future water demands could also be supplied by expansion of waste water reclamation practices. The remaining chapters of this report are devoted to the discussion of waste water reclamation, quantities of reclaimable wastes, quality of waste flows, and plans for reclaiming waste water for lower priority beneficial uses.

CHAPTER III. WASTE WATER FACILITIES AND QUANTITIES

Before the feasibility of reclaiming waste water can be determined, an assessment must be made of the quantities available within the area. This chapter looks at the sources and quantities.

Waste Water Sources and Facilities

The three sources for waste water in Coachella Valley are domestic wastes, industrial wastes, and agricultural return water. Since industrial wastes in the valley are insignificant in amount and agricultural return waters are highly mineralized, only the waste waters from domestic use are of significance to this study.

Domestic Wastes

Because of recent sharp population increases in Coachella Valley, the waste water facilities for domestic wastes have undergone considerable expansion and improvement in the past several years. Consequently, the majority of the municipal treatment plants of the valley are either new or recently improved, and are adequate for the present needs of the area. Almost all the waste waters discharged by these facilities are presently being used for irrigation and ground water recharge.

In the next several decades, a continuation of the present growth in population is expected to yield waste water quantities far in excess of present amounts.

The major waste water facilities in Coachella Valley are one primary and six secondary sewage treatment plants. A brief description of each of the treatment plants is given below under the name of the operating agency. For location of these plants see Plate 1.

City of Banning. The City of Banning has a secondary waste water treatment plant with a design capacity of 3.0 million gallons per day (mgd). Approximately 90 percent of the effluent from this plant is used for crop irrigation and the remainder is used for grounds irrigation at the plant. There are no plans for expansion of these facilities in the immediate future.

Coachella Sanitary District. The Coachella Sanitary District's waste water treatment plant consists of a primary-type facility, followed by oxidation ponds, and has a design capacity of 0.12 mgd. The effluent from this plant is discharged to an adjoining farm where it is used for crop irrigation. There are no immediate plans for increasing the size of this plant.

Indio Sanitary District. The Indio Sanitary District has a secondary waste water treatment plant with a design capacity of 5.0 mgd. The plant provides primary and secondary treatment followed by an oxidation pond. Part of the effluent is used for irrigation and the remainder is discharged to a storm channel. The capacity of this plant is considered adequate for present needs, and expansion is not contemplated for the near future.

Mecca Sanitary District. The Mecca Sanitary District waste water treatment plant has a design capacity of 0.10 mgd and consists of a combined primary and secondary unit. The effluent discharges to the Lincoln Street irrigation return drain with ultimate disposal to the Salton Sea.

Oxidation ponds at Palm Springs Plant

Palm City Water Company. The plant operated by Palm City Water Company provides secondary waste water treatment for Palm Desert Country Club Estates, with a design capacity of 0.10 mgd. The effluent is discharged to an oxidation pond and is used for irrigation of lawns. This plant is designed to be doubled in size at some future date.

City of Palm Springs. The City of Palm Springs waste water treatment plant has a design capacity of 4.2 mgd. The plant operation includes primary and secondary treatment with the effluent being discharged to an oxidation pond. The effluent from the oxidation pond discharges to a golf course lake. This plant was placed in operation in 1960 and is designed so that additional units may be added to increase the capacity to 16 mgd.

Thermal Sanitary District. The Thermal Sanitary District's waste water treatment plant provides primary and secondary treatment at a design capacity of 0.24 mgd. The effluent is discharged to a storm channel with ultimate disposal to the Salton Sea via the Whitewater River. The plant capacity is adequate for present needs, and there are no plans for immediate expansion.

Industrial Wastes

There are only a few sources of industrial wastes in the valley -- they result primarily from packing or canning of agricultural products. The volume of waste is relatively small, and the period of operation is, in general, about four months. At the present time, these industrial wastes are, in most instances, discharged to land or drainage canals and kept separate from the municipal sewer systems.

Agricultural Return Water

Agricultural return waters constitute a large portion of the waste water in Coachella Valley. This water is unsuitable for reclamation because of high mineral content. Ultimate disposal of this water is into the Salton Sea via the Whitewater River. Table 9 presents the yearly flows of this agricultural return water for the period 1948-49 through 1959-60.

TABLE 9

OUTFLOW OF AGRICULTURAL DRAINAGE TO SALTON SEA*

Season	In acre-feet
1948-49	17,700
1949-50	30,600
1950-51	89,300
1951-52	110,800
1952-53	71,700
1953-54	63,700
1954-55	78,300
1955-56	92,400
1956-57	52,600
1957-58	58,900
1958-59	54,600
1959-60	62,200

Adapted from Department of Water Resources Bulletin No. 108, Table 19, page 135.(13) Based on periodic measurements taken by the Coachella Valley County Water District at the Salton Sea discharge points of the tile drain system.

The fluctuations in outflow in Table 9 are caused primarily by variations in regulatory discharges from the Coachella Canal and from field headgates. The lessening of these fluctuations during the last few years reflects increased efficiency in the coordination of water importation with demand.

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*Numbers in parentheses indicate references listed in Appendix A.

Waste Water Quantities

As only the waste water from domestic uses is suitable to be considered for reclamation in Coachella Valley, this discussion of waste water quantities -- which is separated into present and future quantities -- is confined to supplies from domestic uses.

Present Quantities

The total contribution from the seven municipal waste water treatment plants for the fiscal year 1962-63 was more than 4.8 mgd, or 5,365 acre-feet. Waste water flows for the years 1955-56 through 1962-63 are given in Table 10. Figure 2 shows the average, maximum, and minimum monthly flows from Indio and Palm Springs for fiscal year 1962-63.

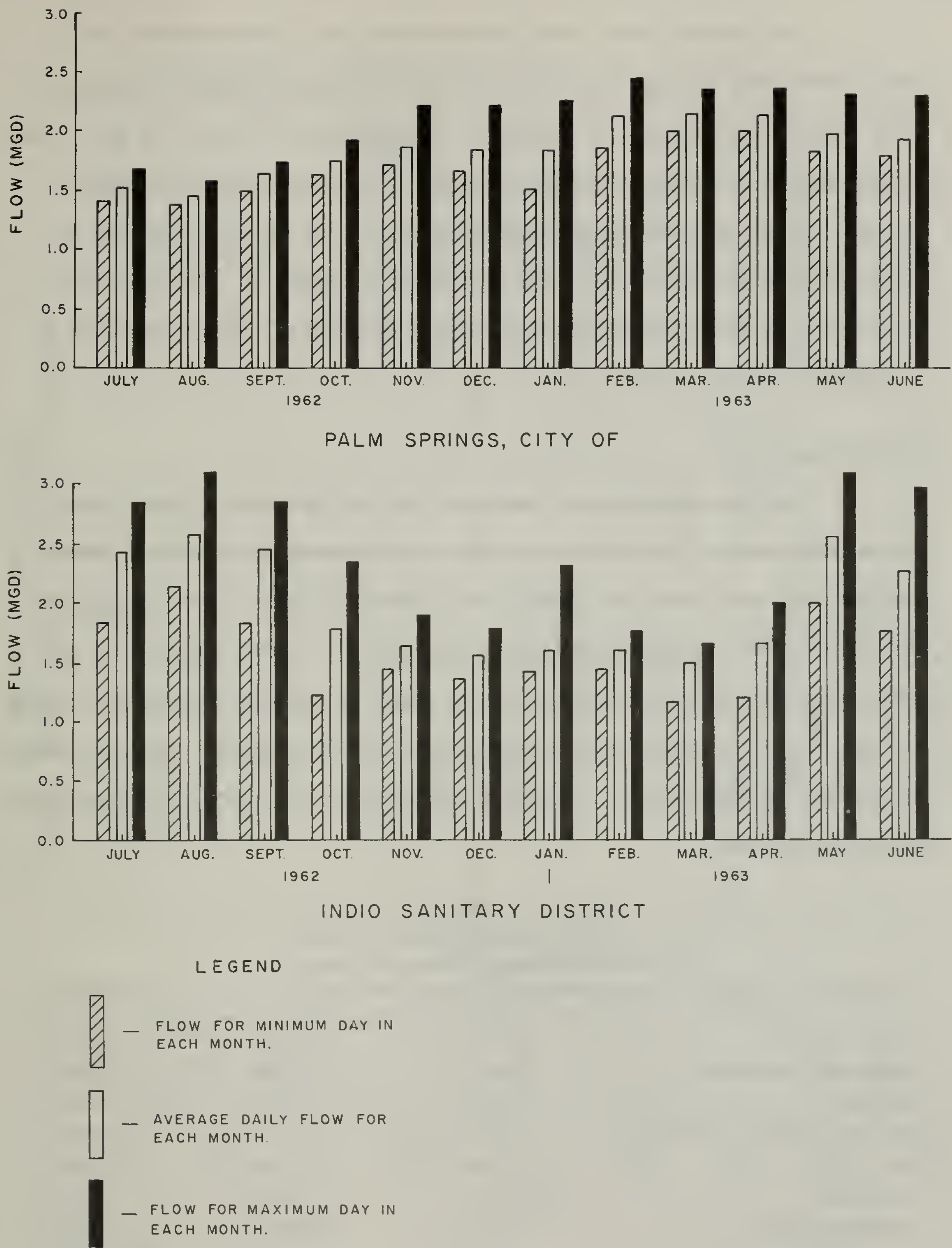
TABLE 10

HISTORICAL QUANTITIES OF DOMESTIC WASTE WATER DISCHARGED IN COACHELLA VALLEY

In $\frac{\text{million gallons per day}}{\text{acre-feet per year}}$

Agency	1955-56	1956-57	1957-58	1958-59	1959-60	1960-61	1961-62	1962-63
City of Banning	--/--	--/--	--/--	--/--	--/--	--/--	--/--	0.4/448
Coachella Sanitary District	--/--	--/--	0.5*/560*	0.6*/720*	0.5*/560*	0.5*/560*	0.5*/560*	0.5*/560*
Indio Sanitary District	1.2*/1,370*	1.5*/1,730*	1.5*/1,730*	1.5*/1,730*	1.5*/1,730*	1.7/1,890	1.8/2,016	2.0/2,240
Mecca Sanitary District	--/--	--/--	--/--	--/--	--/--	--/--	--/--	0.02/22
Palm City Water Company	--/--	--/--	--/--	--/--	--/--	--/--	--/--	0.04/45
City of Palm Springs	0.6/710	0.6/710	0.7/760	0.8/870	0.9*/1,040*	0.9*/1,030*	1.4/1,568	1.8/2,016
Thermal Sanitary District	--/--	--/--	--/--	--/--	--/--	--/--	--/--	0.03*/34*

*Estimated



VARIATION OF MONTHLY DISCHARGES
OF SEWAGE

FIGURE 2

Per capita waste water contributions vary widely within the study area. The average contribution from Banning, Coachella, Indio, and Palm Springs during 1962-63 was about 104 gallons per capita per day. The amount varied from 34 gallons per capita per day for Banning to 183 for Indio. The waste water contributions for Indio and Palm Springs for the years 1955-56 through 1962-63 are presented in Figure 3. The sharp rise in per capita contributions from Palm Springs reflects the increase in population served by sewers.

Future Quantities

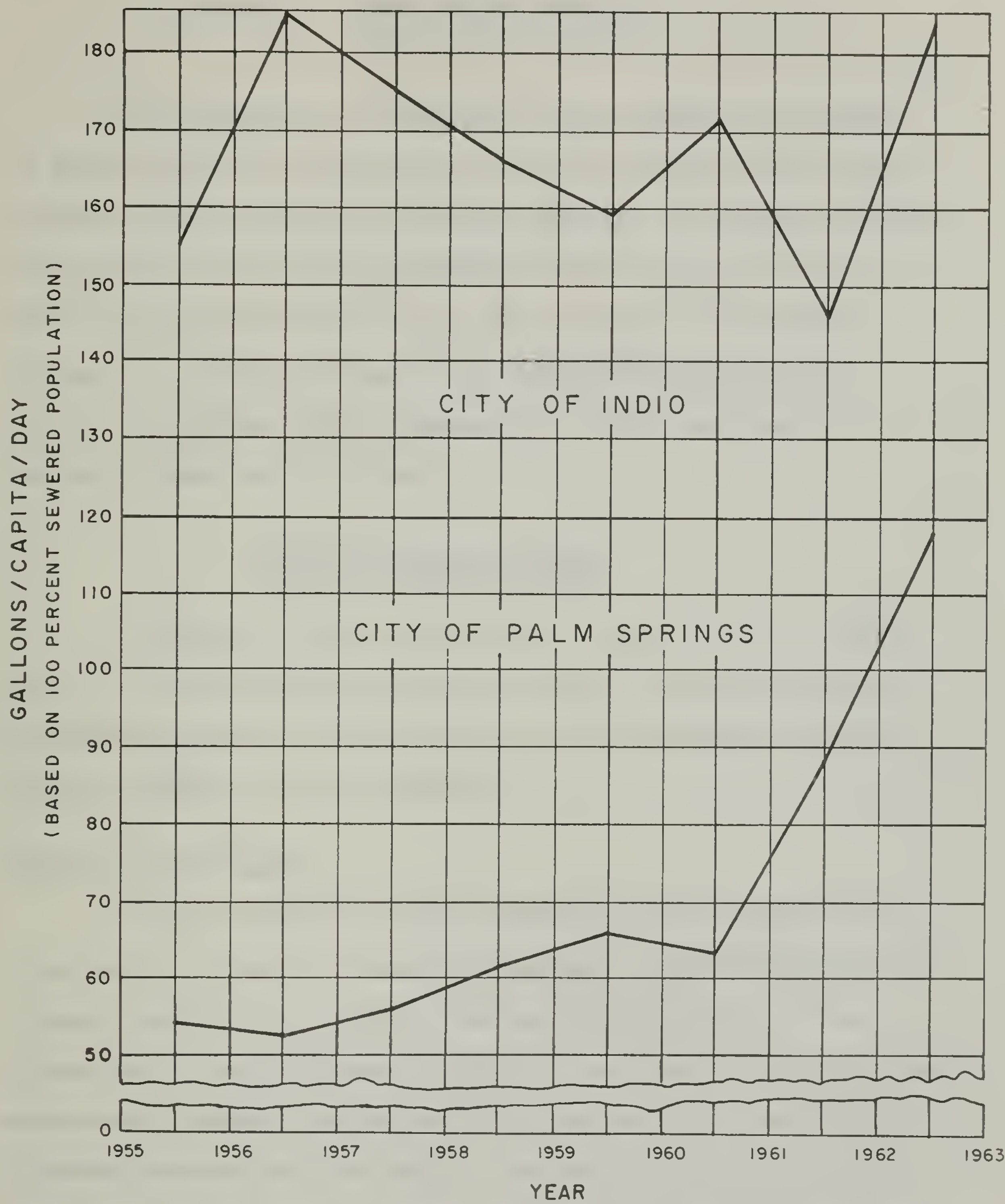
As the population of Coachella Valley continues to grow, the urban waste water flows will increase. To determine the expected contributions from each area, the population figures in Table 4 were multiplied by the expected per capita per day waste, which is about 170 gallons per capita per day waste for Indio based on Figure 3 and 100 gallons per capita per day waste for other areas based on the 1962-63 average. Table 11 gives the estimated future waste water contributions of the major populated areas in the study area.

TABLE 11

PROJECTED QUANTITIES OF DOMESTIC WASTE WATER

In million gallons per day/acre-feet per year

Area	1970	1980	1990
Banning - Cabazon	1.5/1,680	2.1/2,350	2.7/3,020
Cathedral City - Palm Desert	0.6/670	1.2/1,340	2.4/2,690
Coachella	0.8/900	1.3/1,460	2.0/2,240
Desert Hot Springs - North Palm Springs	0.5/560	1.0/1,120	2.0/2,240
Indio	2.9/3,250	4.9/5,490	8.3/9,300
Palm Springs	2.8/3,140	4.5/5,040	6.9/7,730
Miscellaneous urban	0.5/560	0.8/900	1.2/1,340
TOTAL	9.6/10,760	15.8/17,700	25.5/28,560



PER CAPITA WASTE WATER CONTRIBUTION

CHAPTER IV. WATER QUALITY FACTORS IN WASTE WATER RECLAMATION

The feasibility of reclamation of waste water for beneficial use depends primarily on the quality of the waste water because quality determines its suitability for each particular use. This chapter presents the principal factors affecting quality of waste water, the results of field surveys of waste water quality, the criteria of suitability for reclamation, and the classification for reclamation of waste waters in the study area. Water quality standards and criteria are presented in Appendix C, "Water Quality Criteria".

Factors Affecting the Mineral Quality of Waste Waters

The quality of waste water flows is influenced by three major factors: the mineral quality of the water supply, the mineral pickup resulting from domestic and industrial use, and the quantity and quality of water infiltering the sewer system.

Quality of Water Supplies

The most significant factor affecting quality of waste waters is the quality of the water supplied to the area. As previously discussed, the water supply for the valley is obtained from three sources: the Colorado River, the local ground water basin, and minor contributions from surface water sources. Another source of minor amounts of water used in the valley is waste water reclamation. The quality of this water is discussed later in this chapter. Future supplies will come from these same sources and also from Northern California.(8)*

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*Numbers in parentheses indicate references listed in Appendix A.

Colorado River Water. Colorado River water is imported to Coachella Valley for agricultural irrigation. The quality of this water is class 2 for irrigation. Mineral analyses of samples obtained from the Coachella Canal and the All-American Canal are presented in Table 12. Plate 1 shows the sampling point for the Coachella Canal. The All-American Canal is not in the area of investigation.

TABLE 12

MINERAL ANALYSES OF IMPORTED COLORADO RIVER WATER

Constituent*	Coachella Canal at Avenue 52	All-American Canal**
Date sampled	8-12-58	5-13-64
pH	8.1	8.0
EC x 10^6 at 25° C.	1,080	1,219
Calcium	79	93
Magnesium	28	34
Sodium	110	130
Potassium	4.3	5.1
Carbonate	0	0
Bicarbonate	143	171
Sulfate	130	326
Chloride	213	125
Nitrate	0	1.5
Fluoride	--	0.54
Boron	0.15	0.16
Silica	--	11
Total dissolved solids	727	828
Total hardness as $CaCO_3$	--	372
Percent Sodium	43	43

*All chemical constituents in parts per million except pH, EC, and percent sodium.

**Sampling point prior to diversion into Coachella Canal.

Ground Water. Mineral analyses of wells considered as representative of ground waters in the valley are presented in Table 13 and sampling locations are shown on Plate 1. A summary of these analyses shows a range of constituents as follows: electrical conductance in EC x 10^6, 208 to 1,587; chloride, 7 to 142 ppm; boron, 0 to 1.6 ppm; and sodium, 18 to 85 percent. Based on these results, ground waters vary in quality from class 1 to class 3 irrigation water. Class 2 and 3 waters fall into those categories mainly because of high sodium content.

TABLE 13

MINERAL ANALYSES OF REPRESENTATIVE GROUND WATERS IN COACHELLA VALLEY

Constituent*	Fargo Canyon 4S/8E-31R	Garnet Hill 3S/4E-15R	Indio (shallow) 6S/8E-7P	Indio (deep) 7S/8E-26	Miracle Hill 3S/5E-10J	Mission Creek 3S/4E-2E	Oasis 8S/9E-31R	Palm Springs 4S/4E-1N	San Gorgonio Pass 3S/2E-7D	Sky Valley 3S/6E-28A	Thousand Palms 4S/6E-8L
Date sampled	2-28-61	10-3-62	1-28-64	4-9-52	10-3-62	8-19-55	6-1-60	11-17-59	10-24-60	3-21-61	2-1-61
pH	7.6	8.1	8.3	8.2	7.6	--	7.8	7.3	7.5	7.6	8.2
EC x 10^6 at 25° C.	1,055	386	583	208	1,587	594	1,246	283	282	1,545	913
Calcium	44	6	71	9	39	53	54	34	24	36	54
Magnesium	1	6	3.6	0	2	10	11	3	12	4	17
Sodium	182	64	36	40	310	52	192	10	18	282	113
Potassium	8	3	3.5	1.5	8	--	14	--	1.6	6.3	8.8
Carbonate	0	0	0	0	0	3	0	6	--	0	0
Bicarbonate	107	92	118	90	55	140	220	109	161	52	131
Sulfate	284	80	82	30	550	148	225	10	4.8	500	276
Chloride	74	18	62	10	121	21	142	7	12	106	39
Nitrate	27	2	5	1.5	0	0	6	0	0	6.2	2.1
Fluoride	6.3	0.1	0.6	--	7.6	0.6	1.0	0.6	0.8	8.7	1.2
Boron	0.17	0	0	0.02	1.6	0	0.50	0.20	0	0.69	0.09
Silica	18	--	--	--	--	--	--	--	4	14	18
Total dissolved solids	692	--	348	147	--	--	786	--	163	962	624
Total hardness as $CaCO_3$	113	40	192	--	106	174	181	98	109	108	203
Percent sodium	76	76	29	79	85	39	68	18	26	84	53

*All chemical constituents in parts per million except pH, EC, and percent sodium. EC is electrical conductance in micromhos per centimeter at 25° C.

Surface Water. Surface waters in the study area occur as intermittent stream flows originating mainly as runoff from surrounding mountains. Surface flows are, in general, of class 1 irrigation water quality. Mineral analyses of representative surface waters are presented in Table 14. A summary of these mineral constituents follows: electrical conductance as EC x 10^6, 115 to 451; chloride, 3 to 16 ppm; boron, 0 to 1 ppm; and sodium, 11 to 34 percent.

TABLE 14

MINERAL ANALYSES OF REPRESENTATIVE SURFACE WATERS IN COACHELLA VALLEY

Constituent*	Mission Creek 3S/4E-24	San Gorgonio River 3S/1E-12	Snow Creek 3S/3E-33	Tahquitz Creek 4S/4E-22	Whitewater River 3S/3E-2
Date sampled	4-7-58	4-7-58	10-10-63	10-10-63	5-10-64
pH	7.3	7.8	8.2	7.9	7.8
EC x 10^6 at 25° C.	182	320	115	273	451
Calcium	26	32	13	29	59
Magnesium	9	13	1.1	5.9	15
Sodium	6	14	9.2	18	16
Potassium	2.4	2.8	1.6	5.0	4.7
Carbonate	0	0	0	0	0
Bicarbonate	113	160	66	153	2.37
Sulfate	17	12	0	0	41
Chloride	6	16	3	9	4.5
Nitrate	1.15	1.21	0	0	1.6
Fluoride	0.11	0.08	0.1	0.1	0.95
Boron	0	1	0.04	0.04	0
Silica	20	12	--	--	19
Total dissolved solids	118	209	94	190	275
Total hardness as $CaCO_3$	--	134	37	97	209
Percent sodium	11	18	34	27	14

*All chemical constituents in parts per million except pH, EC, and percent Na. EC is electrical conductance in micromhos per centimeter at 25° C.

Future Water. Future water supplies will include Northern California water from the State Water Facilities. The probable mineral quality of this water is presented in Table 15. Based on this analysis, Northern California water can be designated as class 1 according to irrigation water standards. Thus, the overall quality of future waste water will be maintained and possibly improved by the addition of this imported water to existing supplies.

TABLE 15

PROBABLE MINERAL QUALITY OF NORTHERN CALIFORNIA WATER DELIVERED TO SOUTHERN CALIFORNIA BY THE STATE WATER PROJECT*

Mineral constituent	Concentration, in parts per million (except as noted)
Hydrogen ion concentration (pH)	7.1-8.2**
Electrical conductance ($EC \times 10^6$ at 25° C.)	311**
Calcium and magnesium (Ca and Mg)	30-35
Sodium and potassium (Na and K)	28
Carbonate (CO_3)	0
Bicarbonate (HCO_3)	100
Sulfate (SO_4)	34
Chloride (Cl)	30
Nitrate (NO_3)	2
Fluoride (F)	1.5
Boron (B)	0.5
Silica (SiO_2)	20
Total dissolved solids (TDS)	200
Total hardness as calcium carbonate	100
Percent sodium (% Na)	40**

*Adopted from Department of Water Resources Bulletin No. 78, Appendix B, Table 19, page 75.(7)
**In standard units for this property.

Incremental Mineral Increases

Domestic and industrial use can result in extensive deterioration of the mineral quality of water. The extent of mineralization depends on the particular use of the water. Increase in mineralization resulting from domestic use was studied by the University of California at Los Angeles in preparing a report on waste water reclamation and utilization for the California State Water Pollution Control Board (now State Water Quality Control Board). The results of that study are summarized in Table 16.

Industrial waste waters in the study area consist primarily of wash waters from vegetable and fruit-processing plants. These flows are seasonal and of small size and therefore may be considered negligible for the purposes of this study.

TABLE 16

NORMAL RANGE OF MINERAL PICKUP IN DOMESTIC SEWAGE*

Mineral constituent	Normal range, in parts per million (except as noted)
Total dissolved solids (TDS)	100-300
Boron (B)	0.1-0.4
Percent sodium (% Na)	5-15**
Sodium (Na)	40-70
Potassium (K)	7-15
Magnesium ($CaCO_3$)	15-40
Calcium ($CaCO_3$)	15-40
Total nitrogen (N)	20-40
Phosphate (PO_4)	20-40
Sulfate (SO_4)	15-30
Chloride (Cl)	20-50
Total alkalinity ($CaCO_3$)	100-150

*Adopted from State Water Pollution Control Board Publication No. 9, Chart 1-8, page 25.
**In percent.

Infiltration Water

Infiltration of water into sewer systems, depending upon quality and quantity, can seriously affect the quality of waste waters. The quantity of water infiltering a sewer system depends primarily on three factors: quality of construction of sewer system, height of ground water table, and character of the soil. Of particular concern is the fact that in the portions of Coachella Valley that overlie the semiperched water zone, the high water table could induce infiltration of low quality irrigation return waters. These would cause the deterioration of waste water quality.

TABLE 17

MINERAL ANALYSES OF WASTE WATER DISCHARGES
IN COACHELLA VALLEY

Constituent*	City of Banning	Coachella Sanitary District	Indio Sanitary District	Mecca Sanitary District	Palm City Water Company	City of Palm Springs	Thermal Sanitary District
Date sampled	1-17-64	1-14-64	1-14-64	1-14-64	1-24-64	12-20-63	1-15-64
pH	7.6	7.6	7.4	8.2	7.3	7.4	7.6
EC x 10^6 at 25° C.	870	1,200	720	1,500	520	600	1,350
Calcium	32	19	25	9.2	26	17	26
Magnesium	18	27	12	11	10	12	10
Sodium	113	155	93	300	65	85	265
Potassium	15	19	18	31	17	12	15
Ammonium	28	53	21	1.6	0.9	10	23
Carbonate	0	0	0	0	0	0	0
Bicarbonate	380	411	266	13	127	110	247
Sulfate	67	136	81	205	50	30	233
Chloride	57	110	64	272	39	76	165
Nitrate	0	0	0	100	33	74	5.4
Fluoride	0.8	0.4	0.4	0.8	0.4	1.6	0.8
Boron	0.52	0.35	0.54	0.40	0.57	0.67	0.76
Silica	33	36	28	24	27	31	21
Total dissolved solids	556	750	546	1,010	398	446	846
Total hardness as $CaCO_3$	155	158	112	70	101	91	107
Noncarbonate hardness as $CaCO_3$	0	0	0	59	0	2	0
Organic nitrogen as N	5	8	8	1.3	2.2	4.1	3
Nitrite as N	0.03	0.00	0.04	0.02	0.17	0.40	0.63
Orthophosphate	35	58	34	26	34	30	22
ABS detergents	8.2	8.7	7.3	4.6	1.8	4.2	2.2
Percent sodium	49	51	51	85	50	58	75

*All chemical constituents in parts per million except pH, EC, and percent sodium.

Other Factors

Industrial products such as plastics, fibers, medicinal chemicals, dyes, and synthetic detergents find their way into waste waters through domestic and industrial use. Certain of these products can be detrimental to the reclamation of water because they cannot be removed by conventional waste treatment plant methods. Synthetic detergents in particular have caused concern in the reclamation of waste waters because they have contained a foaming constituent that cannot be broken down in normal sewage treatment. However, the present trend is toward the development of biodegradable products that will lessen and possibly eliminate the persistence of this foaming.

Quality of Waste Water

Waste water treatment plant effluents in Coachella Valley are, in general, of a high quality. Mineral analyses of these waste waters are presented in Table 17. A summary of these analyses gives the following ranges: electrical conductance, 520 to 1,500 micromhos at 25° C; boron, 0.35 to 0.76 ppm; and sodium, 49 to 85 percent. The overall quality of these waste waters is class 2 for irrigation. An exception is Mecca where high sodium content places its waste water in class 3.

Agricultural return water represents a large portion of the waste water produced in the Valley. A mineral analysis is in Table 18.

TABLE 18

MINERAL ANALYSES OF AGRICULTURAL RETURN WATER

Constituent*	Whitewater River**
Date sampled	12-18-63
pH	8.2
EC x 10^6 at 25° C.	3,320
Calcium	216
Magnesium	21
Potassium	14
Sodium	650
Carbonate	0
Bicarbonate	344
Sulfate	941
Chloride	479
Nitrate	20
Fluoride	3.0
Boron	0.93
Silica	17
Total dissolved solids	2,510
Total hardness as $CaCO_3$	625
Percent sodium	69

*All chemical constituents in parts per million except pH, EC, and percent sodium.
**Sampling point at entrance to Salton Sea.

This water resulting from irrigation is drained from the area by a system of land tiles and drainage ditches which are tributary to the Whitewater River. From there it drains to the Salton Sea. The overall quality of this water is class 3 -- injurious to unsatisfactory -- according to irrigation water standards. These waters must be wasted so as to maintain a proper salt balance in the soil.

Waste Water Quality Criteria for Reclamation

Evaluation of a waste water flow to determine its suitability for reclamation should be based on three factors: first, the concentration and character of mineral constituents; second, the criteria for the particular use of the reclaimed water; and third, the relative quality, availability and cost of other sources of water. These factors were considered in establishing the mineral quality criteria for waste water given here.

General mineral quality criteria have been developed to judge the suitability of waste water for reclamation and are presented in Table 19. Waste waters are classified according to the least desirable class in which any of the four constituents falls.

TABLE 19

CLASSIFICATION OF THE MINERAL QUALITY OF WASTE WATER FOR RECLAMATION PURPOSES IN COACHELLA VALLEY

Constituent	Limiting values (ppm)		
	Suitable	Marginal	Unsuitable
Chlorides	Less than 200	200 to 350	More than 350
Chlorides and sulfates	Less than 500	500 to 1,000	More than 1,000
Boron	Less than 1	1 to 2	More than 2
Total dissolved solids	Less than 1,000	1,000 to 2,000	More than 2,000

Waste waters classed as suitable with respect to the constituents considered can, for the most part, be reclaimed successfully for prevailing and potential beneficial uses. Waste waters classed as unsuitable would, in general, not meet the quality requirements for normal beneficial uses. It must be recognized that these classifications are not all inclusive. Waste water classed as suitable or marginal by these criteria could be unacceptable for reclamation purposes by reason of excessive concentrations of other pollutions such as synthetic detergents, phenolic compounds, hexavalent chromium, or nitrates.

Suitability of Waste Water for Reclamation in Coachella Valley

Waste waters are classified as suitable, marginal, or unsuitable for reclamation according to the constituents and limits presented in Table 19. A comparison of the data in Tables 17 and 19 indicates that all of the seven major waste discharges in the study area are suitable for reclamation except the Mecca Sanitary District discharge which is marginal. Based on waste water quantities for the 1962-63 fiscal year presented in Table 10, almost 4.8 mgd, or 5,365 acre-feet per year, is suitable for reclamation and about 0.02 mgd, or 22 acre-feet per year, is marginal for reclamation.

CHAPTER V. FEASIBILITY OF RECLAMATION

For waste water reclamation to be feasible in Coachella Valley, it is necessary that: (1) There are demand and use for reclaimed waste water; (2) There is a source of suitable quality reclaimable waste water; (3) The cost of reclaimed waste water is competitive with water from other sources; and (4) The agency financing the reclamation project has legal protection for its investment. This chapter explores each of these criteria.

Demand and Use for Reclaimed Waste Water

Water supplies and requirements in Coachella Valley were compared in Chapter II and it was found that an overdraft condition exists and there is a supplemental water requirement. This need for additional water supplies will increase in the future as a result of the expected increase in population and expansion of irrigated agriculture. Therefore, the demand for reclaimed waste water, as one water source, may be expected to undergo an accompanying growth.

To delineate the places of potential use, the Valley is divided in this report into two areas -- the upper Valley and the lower Valley. The upper Valley includes all the study area except that covering the semi-perched ground water table, which is the lower Valley, as shown on Plate 1.

Potential Use in Upper Valley

The major potential uses of reclaimed waste water in the upper Valley are irrigation of golf courses and ground water recharge. There are approximately 16 golf courses in the Palm Springs-Palm Desert area. Because the majority of these golf courses comprise 18 holes, the irrigation requirements would average about 560 acre-feet per year, or

0.5 mgd per golf course. This indicates a potential waste water use in this area of about 9,000 acre-feet per year, or 8.0 mgd for irrigation of golf courses.

The Coachella Valley County Water District operates two spreading grounds in the upper Valley. One of these spreading grounds is located in the Whitewater River bed just north of Palm Springs. This basin, about 4,000 acres, may be used to spread waste water effluent from the Desert Hot Springs area. The other spreading ground is located just south of Palm Desert in Deep Canyon. This basin, about 360 acres, may be used to spread waste effluent.

Potential Use in Lower Valley

In the lower Valley, water from domestic waste discharges could be reclaimed for irrigation instead of being wasted to the Salton Sea. Another approach for utilization of this water is to blend it with Colorado River water from the Coachella Branch of the All-American Canal for agricultural uses.

Waste Water Source

The sources of Coachella Valley waste water and their quantity and quality are discussed in Chapters III and IV. From these chapters, it is concluded that there is an adequate source of waste water of a mineral quality better than that of Colorado River water.

Costs of Waste Water Reclamation

Costs of reclamation vary, depending on the quantity of waste water needed, the type of treatment, operation, storage, transmission, and water use.

One of the most widely accepted types of treatment for waste water reclamation is the activated sludgé method. Costs per acre-foot for the construction and the operation of activated sludge-type plants, based on past studies(3,17)*, are shown on Figure 4. Construction costs were based on the capital recovery of the costs at 5 percent interest rate and an expected 25-year life for the plants.

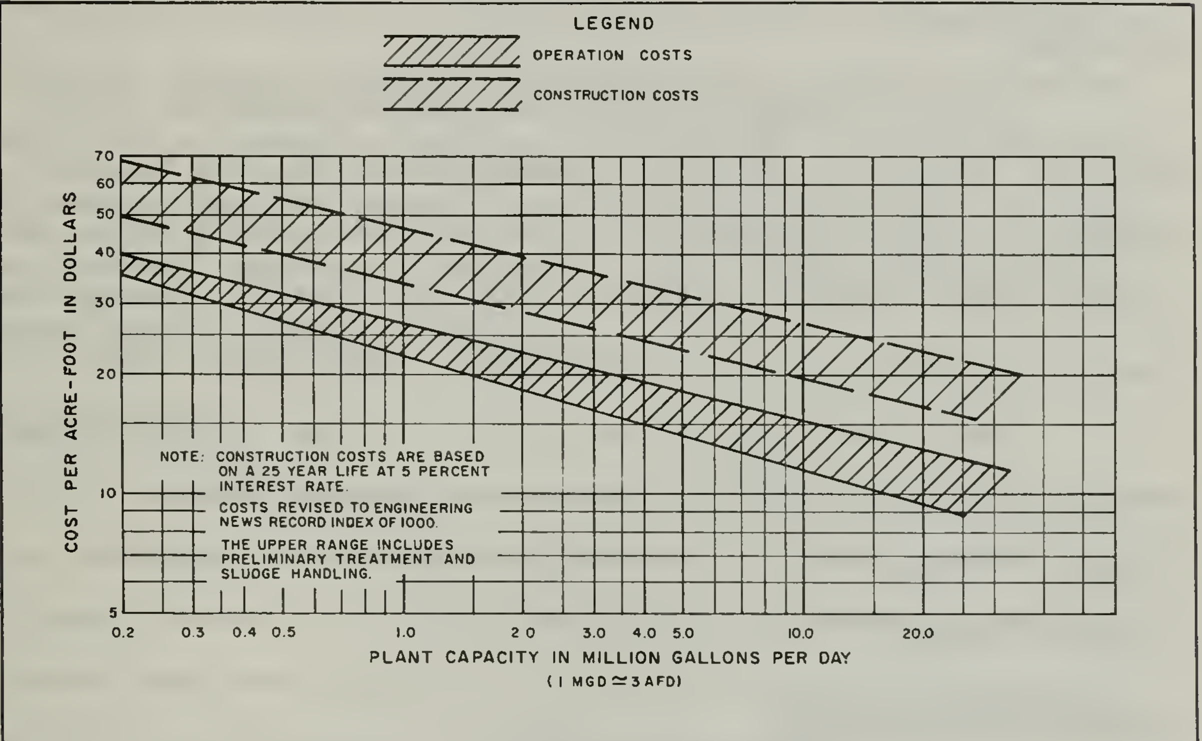


FIGURE 4

CONSTRUCTION AND OPERATION COSTS FOR ACTIVATED SLUDGE TYPE WASTE WATER RECLAMATION PLANTS

Storage facilities for waste water are necessary to satisfy fluctuating demand and unexpected shutdowns. For irrigation of parks and golf courses, the water is applied during periods when the park or golf course is not in use. Storage capacity equivalent to 24 hours of this maximum demand should be sufficient. This would probably cost about $2 per acre-foot of capacity based on average daily reclaimed water demand.

*Numbers in parentheses indicate references listed in Appendix A.

Transmission of waste water requires transmission pumps, structures, transmission pipe, and other necessary appurtenances in order to transport the water from storage to the point of use. Cost of transmission varies, depending on size of mains, distance, and difference in elevation between storage and point of application. The transmission costs may range from 0 to $10 per acre-foot with pumping costs from 0 to $8 per acre-foot.

Water use determines not only the treatment needed and storage necessary, but also the size of the treatment plant. To allow for fluctuations in demand of waste waters for irrigation in Coachella Valley, the treatment plant should be designed for flows of 150 percent of average daily irrigation demand, based on the maximum month given in Table 3, Chapter II.

The nutrient value of waste water is very important when these waters are used for irrigation. These values were not considered in this report. However, it has been reported that the fertilizer value of treated sewage effluent is $18 per acre-foot.(3)

Costs in Coachella Valley

In studying waste water reclamation in Coachella Valley, the investigator is at a decided advantage. He is dealing with an area in which reclamation is already being practiced, and thus he has actual experience to guide him.

As practiced in the Valley, waste water reclamation has proved to be very economical. No figures on costs have been published, but a reasonable assumption, based on 0 to $10 per acre-foot transmission costs, is that waste water is being reclaimed at a cost of approximately $5 per acre-foot beyond the cost of treatment and disposal.

A favorable combination of factors is responsible for this. One of the primary determinants of reclamation costs is the proximity of sewage treatment plants to the area of reuse. In Coachella Valley, all present plants are located only a short distance from areas of use. A second determining factor is the amount of treatment required to bring waste water to the standards set by the health department for the particular use. As has been pointed out, waste water in Coachella Valley is of a high quality and no special treatment beyond that for normal sewage treatment is required. Third, from a reclamation standpoint, it is cheaper to combine waste water reclamation with sewage disposal because treatment and disposal of wastes are necessary, regardless of reclamation. This is the practice with all present plants in Coachella Valley.

Comparative Costs

To obtain a basis for comparing costs of reclaimed water with costs of water from other sources requires the establishment of the costs of sewage treatment and disposal. Also, the costs of obtaining other supplemental fresh water supplies for the Valley are needed for comparison. These costs are discussed in the following paragraphs.

Cost of Reclamation.[3,14,16,17] For sewage treatment and disposal without reclamation, the most economical installation is one large plant to serve the entire Valley. Therefore, to estimate the cost of sewage treatment and disposal without reclamation, a hypothetical plant was "built". The plant would be constructed below Indio to serve all the Valley except the San Gorgonio Pass area. It would be designed for the 1990 Valley waste water flow, which is 22.8 mgd, as shown in Table 11.

The cost of constructing and operating the plant at design capacity -- based on the upper range for disposal treatment costs on Figure 4 -- would be $35 per acre-foot. This does not include the capital costs of trunk sewers, which may be $5 to $10 per acre-foot.

For reclamation of waste water in addition to sewage treatment and disposal, numerous smaller combination treatment and reclamation plants would be constructed throughout the Valley. These smaller plants would have exactly the same treatment phases as the larger hypothetical plant but would be dispersed so as to be located closer to points of use of reclaimed waste water. For example, one of the smaller plants would be in the Cathedral City-Palm Desert area which has an estimated 1990 sewage flow of 2.4 mgd. From Figure 4, the cost of constructing and operating this plant at design capacity would be $59 per acre-foot. Reclamation costs would be the difference between the cost per acre-foot of treating 2.4 mgd and the cost per acre-foot of treating 22.8 mgd, or $24 per acre-foot. Deducting $7 per acre-foot for the construction of trunk sewers to serve the single large treatment plant, the cost would be $17 per acre-foot. This does not include the $5 per acre-foot reclamation cost beyond the cost of treatment and disposal.

<u>Costs of Other Supplemental Water Supplies</u>. In the lower Valley, imported Colorado River water available for irrigation is inexpensive. At $2 to $3 per acre-foot for irrigation use, it is much cheaper than reclaimed waste water. However, this water is limited in quantity and its use can probably not be expanded much beyond its present amounts.

In the upper Valley where Colorado River water has not been imported, users have overdrafted the limited supply of ground water. Cost of pumping ground water in the Palm Springs area is about $30 per acre-foot. Water from the State Water Project delivered to this area will probably cost somewhat in excess of $60 per acre-foot.[2] Both of these figures exceed the $17 cost for reclaimed waste water.

Legal Requirements

Consideration must, at all times, be given to regulations that are imposed on the reclamation of water from wastes by local authorities, California State Department of Public Health, State Water Quality Control Board, and regional water quality control boards.

The power to abate contamination is given to the California State Department of Public Health by the Health and Safety Code, Sections 5410 to 5413, which prohibits discharges of sewage effluent in any manner that will result in contamination or nuisance. Power to issue regulations concerning pollution and nuisance resulting from sewage effluent discharge is vested in the regional water quality control boards by the State Water Code, Section 13053.

Use of reclaimed water through injection into an aquifer is permitted by Section 4458 of the Health and Safety Code, upon a finding by the regional water quality control board that "water quality considerations do not preclude" injection operations, and the operation is carried out under the supervision of the State Board of Public Health.

With the above qualifications, the necessary relationships in the utilization of reclaimed water fall into established contractual and water rights patterns. The user of reclaimed water would want to assure himself of rights to a firm enough supply to warrant investment in treatment and conveyance facilities. Agreement concerning quality of the reclaimed water and liability for failures in the system should be executed between producer and user.

Public agencies should be certain that they have the authority to enter into the necessary agreements to utilize reclaimable water. Authority to sell or dispose of effluent for reclamation is expressly granted by Health and Safety Code, Section 5008, to cities, counties, corporations, and districts operating sewage treatment systems.

CHAPTER VI. EXISTING AND POTENTIAL WASTE WATER RECLAMATION PROJECTS

Pertinent to this report on feasibility of waste water reclamation in Coachella Valley is the following discussion of existing and potential water reclamation projects in the Valley.

Existing Projects

Waste water reuse exists at several places in the Coachella Valley. Of the 4.8 mgd of domestic waste water discharged, about 3.7 mgd is either directly or indirectly reclaimed. The major locations where water is reclaimed from sewage in the upper Valley are at Banning, Palm City, and Palm Springs, and in the lower Valley at Coachella and Indio. Water is reclaimed indirectly, or involuntarily, at several locations where septic tanks or cesspools are used to dispose of the sewage. For location of the major reclamation systems see Plate 2.

Banning

About 90 percent of the effluent from the Banning Sewage Treatment Plant is reclaimed for irrigation of alfalfa at a nearby farm. The remainder of the effluent is used to irrigate grass and shrubbery at the plant site. During wet seasons, waste effluent not needed for irrigation is discharged to a five-acre pond where it percolates to the underlying ground water basin.

Coachella

All the waste effluent discharged from the Coachella Sanitary District's sewage treatment plant is reclaimed for irrigation of cotton, alfalfa, and sugar beets.

Indio

The City of Indio leases 40 acres of land to a farmer who utilizes one-quarter to one-half of the total flow of effluent from the Indio Sanitary District's sewage treatment plant for irrigation of cotton and flowers. The remainder of the flow goes through a storm channel to the Salton Sea. This unused waste water could be used beneficially for the irrigation of a golf course, or could be mixed with Colorado River water from the Coachella Branch of the All-American Canal for irrigation of crops.

Palm City Water Company

Effluent from the Palm City Water Company Sewage Treatment Plant is used for the irrigation of a seeded area around the plant. Plans provide for future increased plant flows being used for irrigation of an 18-hole golf course.

Palm Springs

Part of the waste water from the Palm Springs Sewage Treatment Plant is discharged to a city-owned golf course lake, with the remainder being discharged to a tributary to the Whitewater River. Distribution lines have been constructed for the irrigation of the golf course. Sufficient waste water quantities are available in the lake to irrigate other golf courses in the area.

Potential Projects

At present, most of the waste water effluent of sewage origin in Coachella Valley is being reclaimed, either directly or indirectly. In the future, the reclamation of waste water will depend largely upon the location of future waste discharges in relation to an area of reuse. This section discusses potential waste water reclamation in both the upper and lower Valley.

Upper Valley

Sewage discharged in the upper Valley is presently either directly reclaimed for irrigation or indirectly reclaimed by percolation in the ground water basin. The major population centers in the upper Valley without sewage treatment facilities, other than septic tanks, are Palm Desert and Desert Hot Springs. A future waste water reclamation plant could be constructed for each of these areas to serve some of the water requirements, providing that waste effluent is suitable for reclamation.

Desert Hot Springs. A waste water reclamation plant could be constructed south of Desert Hot Springs near North Palm Springs to serve the anticipated population in this area. The plant would serve as both a disposal plant and a reclamation plant. Effluent from the plant could be spread in the Whitewater River spreading grounds or be used to irrigate a future golf course.

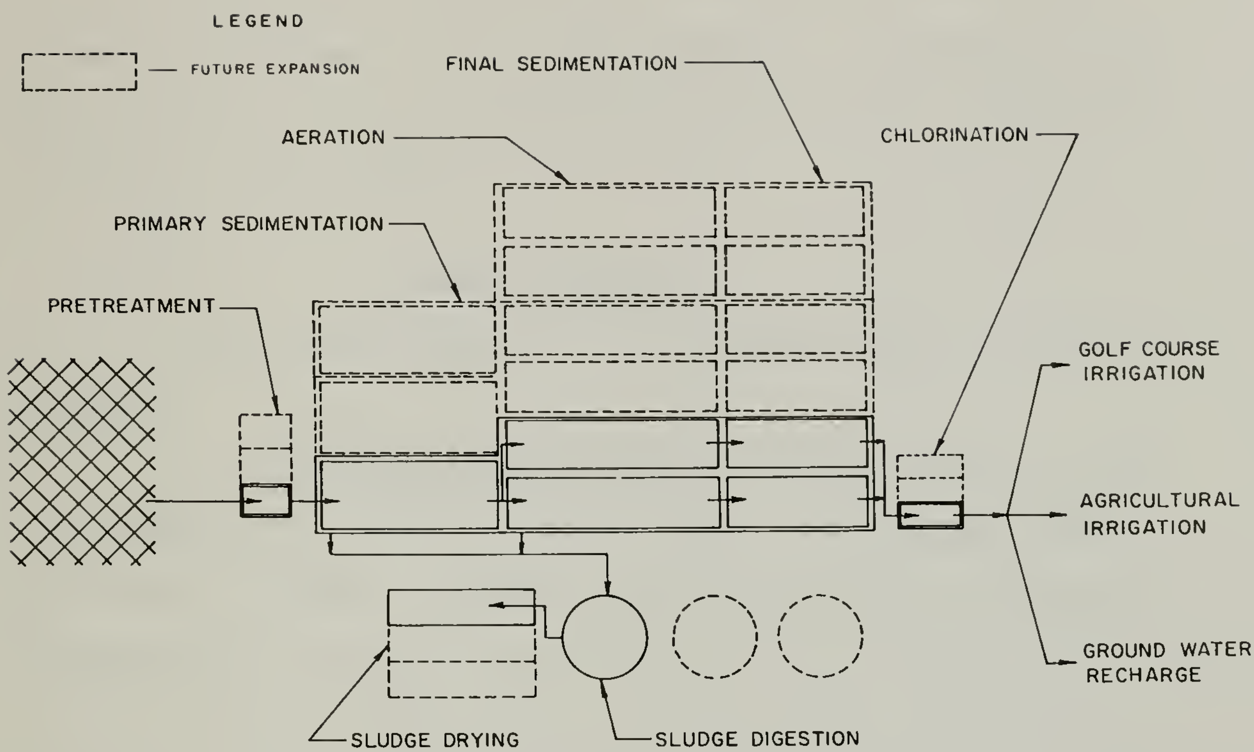
This plant could be designed to process 2.0 mgd of waste water, the estimated waste water flow from Desert Hot Springs and North Palm Springs in 1990. The plant could be constructed and operated for about $62 per acre-foot for 2.0 mgd of waste processed. This is the cost of treating and disposing of the wastes only; the cost of reclaiming the water would include only the costs of transmitting, pumping, and distributing the water. This plant is located on Plate 2 and diagrammed on Figure 5.

Palm Desert. A waste water reclamation plant could be built on the banks of the Whitewater River near Palm Desert to serve the future population of the Cathedral City-Palm Desert area. It is estimated the waste water contribution from this area will be about 2.4 mgd by 1990. The plant would serve as both a disposal plant and a reclamation plant. Effluent from the plant could be spread in the Deep Canyon spreading grounds, used to irrigate golf courses in the area, used to form decorative lakes in the Whitewater River bed, or used for irrigation through mixing with water from the Coachella Canal.

This plant could be constructed and operated for about $59 per acre-foot for 2.4 mgd of waste water processed. Because of the proximity of this area to Indio, it would undoubtedly connect with a central waste disposal plant if one were built in Indio. Therefore, the cost of reclaiming water from this small plant is based on the difference between $59 and $42 ($35 plus $7, as shown in Chapter V) plus the costs of transmitting, pumping, and distributing the water. This plant would be similar to the Desert Hot Springs Plant.

Lower Valley

Reclamation of waste water by percolation into the ground water basin in the lower Valley is prevented because of a clay layer near the ground surface, which forms a semiperched water table. In this area, therefore, the most likely potential water reuse is irrigation. Potential reclamation plants south of Indio are not considered in this report because there are sufficient sewage treatment facilities already located at the population centers -- Indio, Mecca, and Thermal.



FLOW DIAGRAM FOR POTENTIAL
WASTE WATER RECLAMATION PLANTS

FIGURE 5

CHAPTER VII. SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

In the preceding six chapters, a discussion of waste water reclamation in Coachella Valley has been presented. The principal findings, conclusions, and recommendations resulting from this investigation are reported in this chapter.

Summary of Findings

From the study reported in this bulletin, come the following findings:

1. The beneficial uses of water in Coachella Valley are domestic consumption; light industry; and irrigation of agricultural lands, golf courses, and parks. Population projections show that both urban and irrigated agricultural requirements will increase in the years ahead.

2. Present water supplies in the study area are mainly from the Colorado River and from the ground water basin. Smaller amounts come from waste water reclamation and negligible amounts from surface runoff. Approximately 65 percent of the supply is from the Colorado River, but it is used only for irrigation of agricultural crops in the southern part of the Valley. Use of water presently exceeds the mean annual supply and an overdraft of 100,000 acre-feet per year exists. In the near future, water from Northern California, through the State Water Project, will provide a supplemental supply which will probably need to be augmented at a later date.

3. The sources for waste water in Coachella Valley are domestic wastes, industrial wastes, and agricultural return water. Only those from domestic wastes are considered suitable for reclamation. At present,

these domestic wastes amount to more than 4.8 million gallons per day (mgd). By 1990, they are expected to total 25.5 mgd.

4. About 3.7 mgd of the treated domestic waste waters are presently being used for irrigation, filling a decorative lake, and ground water recharge. Most of the agricultural return water in the Valley and a small amount of the domestic waste water are drained from the Valley into the Salton Sea.

5. Mineral analyses of the domestic waste waters in Coachella Valley show them to be of a generally high quality. All but those from the waste water treatment plant at Mecca are rated as "suitable" for reclamation. The discharge from the Mecca plant, which rates as "marginal" for reclamation, amounts to 0.02 mgd.

Conclusions

The following conclusions may be drawn from the investigation reported here:

1. As the urban population in the Valley increases, the supply of domestic waste water will increase. The quality of this waste water should be maintained as the supply is supplemented with water from the State Water Project, which is generally high in quality.

2. From the standpoint of supply and demand, quality, economic factors and legal requirements, reclamation of water from domestic wastes in Coachella Valley is feasible. Reclaimed waste water can be considered an economical, suitable supplemental supply for Coachella Valley to be used for irrigation of golf courses and other recreational facilities, thus reducing the overdraft on the ground water supply in the northern

part of the Valley. More expensive water from the State Water Project would be reserved for higher quality domestic uses when it becomes available after 1972.

3. The anticipated population growth of Desert Hot Springs and Palm Desert -- neither of which has a sewage treatment plant other than septic tanks -- makes them sites for potential waste water reclamation plants. Effluent from the plant at Desert Hot Springs could be spread in the Whitewater spreading grounds or used to irrigate a golf course. That from the Palm Desert plant could be spread in the Deep Canyon spreading grounds, used to irrigate golf courses or supplied to decorative lakes.

Recommendations

On the basis of the findings and conclusions of this investigation, it is recommended that:

1. Waste water reclamation in Coachella Valley be continued as a means of conserving the water supply.

2. As the supplies of good quality waste water increase in the future, consideration be given to using these supplies rather than wasting them to the Salton Sea.

3. Future water sewerage studies for Coachella Valley include consideration of waste water reclamation as a means of disposing of waste water.

APPENDIX A

SELECTED REFERENCES

USED IN INVESTIGATION

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SELECTED REFERENCES
USED IN INVESTIGATION

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APPENDIX B

DEFINITION OF TERMS

APPENDIX B

DEFINITION OF TERMS

In this report, certain specialized words and terms are used. Definitions for these terms are given below. Some are based on the "Glossary of Water and Sewage Control Engineering", published by the American Society of Civil Engineers.[1]

Aquifer. A geologic formation or zone sufficiently permeable to yield an appreciable supply of water to wells and springs.

Complete Mineral Analysis. A determination of the concentration of the principal dissolved constituents of water -- calcium, magnesium, sodium, potassium, hydroxide, bicarbonate, carbonate, chloride, sulfate, nitrate, boron, and fluoride. In addition, such an analysis includes determinations of total dissolved solids, electrical conductance, and pH.

Electrical Conductance (EC). The reciprocal of the resistance in ohms measured between opposite faces of a centimeter cube of an aqueous solution at a temperature of 25 degrees centigrade. This is generally expressed in micromhos/cm.

Industrial Waste. Defined in Section 13005 of the California Water Code as, "any and all liquid or solid waste substance, not sewage, from any producing, manufacturing or processing operation of whatever nature".

Involuntary Reclamation. The recovery for beneficial use of waste waters that have lost their identity through mixing with natural streamflow or ground water to which they were discharged in the process of final disposal.

Oxidation Pond. An artificial pond that provides an environment for living organisms which, in the presence of oxygen, convert the organic matter contained in sewage to a more stable or a mineral form.

pH. The logarithm, to the base 10, of the reciprocal of the hydrogen ion concentration, or more precisely, of the hydrogen ion activity in moles per liter.

Planned Reclamation. Any process of recovery of water from waste waters that was originally planned and conceived for the primary purpose of putting the recovered water to beneficial use.

Primary Sewage Treatment. Any process that removes a portion of the suspended and floating matter from sewage or industrial waste by screening, skimming, sedimentation, or other physical means.

Reclamation. The process of recovering water from sewage or industrial wastes so that the water may be put to beneficial use.

Salt Balance. The relationship of salt input to salt output. For example, to maintain a usable quality of ground water, it is necessary to maintain a favorable salt balance where the total mass of dissolved salts entering a ground water basin from all sources of recharge is less than the total mass of dissolved salts removed from the basin by natural outflow and exported extractions.

Secondary Sewage Treatment. Any process of sewage or industrial waste treatment which follows primary treatment, and which accomplishes further stabilization of organic matter by biological or chemical action.

Sewage. Defined in Section 13005 of the California Water Code as, "any and all waste substance, liquid or solid, associated with human habitation, or which contains or may be contaminated with human or animal extreta or excrement, offal, or any feculent matter".

Waste Water. The water that has been put to some use or uses and has been disposed of, commonly to a sewer or wasteway. It may be liquid industrial waste or sewage, or both.

APPENDIX C

WATER QUALITY CRITERIA

WATER QUALITY CRITERIA

For quality standards, water supplies are classified in three general types -- municipal and domestic, agricultural, and industrial.

Municipal and Domestic Water Quality Criteria

Water used for drinking and culinary purposes should be clear, colorless, odorless, pleasant to the taste, and free from toxic salts. It should not contain excessive amounts of dissolved mineral solids, and must be free of pathogenic organisms. Probably the most widely used criteria in determining the suitability of a water for this use are the "Public Health Service Drinking Water Standards, 1962", given in Table C-1.

TABLE C-1

UNITED STATES PUBLIC HEALTH SERVICE
DRINKING WATER STANDARDS, 1962

In milligrams per liter

Substance	Recommended limits of concentrations	Mandatory limits of concentrations
Alkyl benzene sulfonate (ABS)	0.5	--
Arsenic (As)	0.01	0.05
Barium (Ba)	--	1.0
Cadmium (Cd)	--	0.01
Carbon chloroform extract (CCE)	0.2	--
Chloride (Cl)	250	--
Chromium (hexavalent) (Cr^{+6})	--	0.05
Copper (Cu)	1.0	--
Cyanide (CN)	0.01	0.2
Iron (Fe)	0.3	--
Lead (Pb)	--	0.05
Manganese (Mn)	0.05	--
Nitrate (NO_3)*	45	--
Phenols	0.001	--
Selenium (Se)	--	0.01
Silver (Ag)	--	0.05
Sulfate (SO_4)	250	--
Total dissolved solids (TDS)	500	--
Zinc (Zn)	5	--

*In areas in which the nitrate content of water is known to be in excess of the listed concentration, the public should be warned of the potential dangers of using the water for infant feeding.

Maximum safe limits of fluoride ion concentrations are related to mean annual temperature, and are defined by the California State Department of Public Health as follows:

Mean annual temperature, in ^{o}F	Mean monthly maximum fluoride ion concentration, in ppm
50	1.5
60	1.0
70 - above	0.7

Total hardness is a significant factor in the determination of the suitability of water for domestic or municipal use. Waters containing 100 parts per million (ppm) or less of hardness (as $CaCO_3$) are considered "soft", those containing 101 to 200 ppm are considered "moderately hard", and those with more than 200 ppm are considered "very hard".

Irrigated Agriculture Water Quality Criteria

The major criteria used as a guide to judge the suitability of water for irrigation are chloride concentration, specific electrical conductance (presented as EC x 10^6 at 25^{o} C), boron concentration, and percent sodium.

Chlorides are present in nearly all waters. They are not necessary to plant growth, and in high concentrations cause subnormal growing rates and burning of leaves.

Electrical conductance indicates the total dissolved solids, and furnishes an approximate indication of the overall mineral quality of the water. For most waters, the total dissolved solids, measured in parts per million, may be approximated by multiplying the electrical conductance by 0.7. As the amount of dissolved salts in irrigation water increases, the crop yields are reduced until at high concentrations (the value depending on the plant, type of soil, climatological conditions, and amount of water applied), plants cannot survive.

Boron is never found in the free state but occurs in the form of borates or boric acid. This element is essential in minor amounts for the growth of many but not all plants. It is however, extremely toxic to most plants in high concentrations. Limits of tolerance for most irrigated crops vary from 0.5 to 2.0 ppm. Citrus crops, particularly lemons, are sensitive to boron in concentrations exceeding 0.5 ppm.

The percent sodium, as reported in analyses, is 100 times the proportion of the sodium cation to the sum of all cations, all expressed in equivalents per million (epm). Water containing a high percent sodium has an adverse effect upon the physical structure of soils that contain clay by dispersing the soil colloids. This, in turn, retards the movement of water and the leaching of salts, and makes the soils difficult to work. The effect of potassium in water is similar to that of sodium.

Because of the diverse climatological conditions, crops, soils, and irrigation practices in California, criteria set up to establish the suitability of water for irrigation use must be of a general nature, and judgment must be used in application of these criteria to individual cases.

Based on results of studies by Dr. L. D. Doneen, Professor of Irrigation at the University of California at Davis, three general classes of irrigation water have been established:

Class 1 Excellent to Good. Regarded as safe and suitable for most plants under any condition of soil or climate.

Class 2 Good to Injurious. Regarded as possibly harmful for certain crops under certain conditions of soil or climate, particularly in the higher ranges of this class.

Class 3 Injurious to Unsatisfactory. Regarded as probably harmful to most crops and unsatisfactory for all but the most tolerant.

Limiting values for concentrations of chloride, boron, electrical conductance, and percent sodium for these three classes of irrigation water have been established and are shown in Table C-2.

TABLE C-2

UNIVERSITY OF CALIFORNIA CRITERIA
FOR IRRIGATION WATERS

Factor	Class 1 - Excellent to good	Class 2 - Good to injurious	Class 3 - Injurious to unsatisfactory
Electrical conductance, EC x 10^6 at 25° C	Less than 1,000	1,000 - 3,000	More than 3,000
Boron, ppm	Less than 0.5	0.5 - 2.0	More than 2.0
Chloride, ppm	Less than 175	175 - 350	More than 350
Percent sodium	Less than 60	60 - 75	More than 75

Tables C-3 and C-4 were extracted from U. S. Department of Agriculture Technical Bulletin 962, "The Quality of Water for Irrigation Use, 1948", by L. V. Wilcox. Table C-5, also adapted from a United States Department of Agriculture publication, gives additional information.

TABLE C-3

PERMISSIBLE LIMITS OF BORON FOR SEVERAL CLASSES OF IRRIGATION WATER

Classes of water	Crop groups, in ppm		
	Sensitive	Semitolerant	Tolerant
Excellent	Less than 0.33	Less than 0.67	Less than 1.00
Good	0.33 to 0.67	0.67 to 1.33	1.00 to 2.00
Permissible	0.67 to 1.00	1.33 to 2.00	2.00 to 3.00
Doubtful	1.00 to 1.25	2.00 to 2.50	3.00 to 3.75
Unsuitable	Greater than 1.25	Greater than 2.50	Greater than 3.75

TABLE C-4

RELATIVE TOLERANCE OF CROP PLANTS TO BORON

(In each group the plants first named are considered as being more sensitive and the last named more tolerant)

Sensitive to boron	Semitolerant to boron	Tolerant to boron
Lemon	Lima bean	Carrot
Grapefruit	Sweet potato	Lettuce
Avocado	Bell pepper	Cabbage
Orange	Tomato	Turnip
Thornless blackberry	Pumpkin	Onion
Apricot	Zinnia	Broadbean
Peach	Oat	Gladiolus
Cherry	Milo	Alfalfa
Persimmon	Corn	Garden beet
Kadota fig	Wheat	Mangel
Grape (Sultanina and Malaga)	Barley	Sugar beet
Apple	Olive	Palm (Phoenix carariensis)
Pear	Ragged robin rose	Date palm (P. dactylifera)
Plum	Field pea	Asparagus
American elm	Radish	Athel (Tamarix aphylla)
Navy bean	Sweet pea	
Jerusalem artichoke	Pima cotton	
Persian (English) walnut	Acala cotton	
Black walnut	Potato	
Pecan	Sunflower (native)	

TABLE C-5

RELATIVE TOLERANCE OF CROP PLANTS TO SALT*

High salt tolerance	Medium salt tolerance	Low salt tolerance
Date palm	Pomegranate	Pear
Salt grass	Fig	Apple
Bermuda grass	Olive	Orange
Rescue grass	Sweet corn	Grapefruit
Western wheatgrass	Potatoes (White Rose)	Prune
Barley	Carrot	Plum
Sugar beet	Onion	Almond
Rape	Sudan grass	Apricot
Cotton	Alfalfa (California common)	Peach
	Rye	Strawberry
	Wheat	Lemon
	Oats	Avocado
	Orchard grass	Field beans
	Rice	Radish
	Meadow fescue	Celery
	Sorghum (grain)	Meadow foxtail
	Corn (field)	Red clover
	Flax	
	Sunflower	
	Castor beans	

*Taken from Agriculture Handbook No. 60, U. S. Department of Agriculture. February 1954.

Industrial Water Quality Criteria

A standard of quality of water for industrial purposes is exceedingly difficult to ascertain. Industrial usage of water is so varied that a single set of standards for chemical, physical, and bacterial requirements would be meaningless. The attempt made in Table C-6 to assign approximate water quality requirements to general types of industries is, therefore, a very general one, and the quality limits should be considered flexible. Even criteria obtained for the industries mentioned are not conclusive for all constituents. Water used for industrial purposes must, therefore, be considered as a raw material to be treated, if necessary, by the industrial user to fit individual requirements.

TABLE C-6

LIMITS OF MINERAL CONCENTRATIONS, PHYSICAL PROPERTIES, AND SANITARY QUALITY OF WATER FOR VARIOUS INDUSTRIAL USES

Allowable limits in parts per million except as noted

Constituent or property	Boiler feed water[a] boiler pressure in pounds per square inch				Concrete mixing[a,e]	Cooling water[a,f]	Steel manufacturing[a]	Tanning operations[a]	Textile manufacturing[a]	Production of paper[a]	
	0-150	150-250	250-400	over 400						Groundwood[g]	Soda and sulfate pulp[h]
Total Solids	3,000-500[b]	2,500-500[b]	1,500-100[b]	50[b]	--	--	--	--	--	--	--
pH value	8.0 minimum	8.4 minimum	9.0 minimum	9.6 minimum	high values desired	7 to 9[f]	6.8 to 7.0	6.0 to 8.0	--	--	--
Chlorides (Cl)	--	--	--	--	--	--	175	--	100	75	75
Iron (Fe)	--	--	--	--	--	0.5[a]	--	0.1 to 2.0	0.1 to 1.0	0.3	0.1
Manganese (Mn)	--	--	--	--	--	0.5[a]	--	0.1 to 0.2	0.05 to 1.0	0.1	0.05
Iron and Manganese (Fe + Mn)	--	--	--	--	--	0.5[a]	--	0.2	0.2 to 1.0	--	--
Suspended matter	--	--	--	--	--	--	25	--	--	--	--
Temperature, °F.	--	--	--	--	--	--	75	--	--	--	--
Turbidity	20	10	5	1	--	50[a]	--	20	0.3 to 25	--	--
Color	80	40	5	2	--	--	--	10 to 100	0 to 70	30[j]	5[j]
Dissolved oxygen	1.4[c]	0.14	0.0[c]	0.0[c]	--	--	--	--	--	--	--
Hydrogen sulfide (H_2S)	5[d]	3[d]	0[d]	0[d]	--	--	--	--	--	--	--
Total hardness (as $CaCO_3$)	80	40	10	2	100 minimum	50[a]	50	50 to 513	0 to 50	200	100
Sulfate-carbonate ratio (ASME) (Na_2SO_4 : Na_2CO_3)	1:1	2:1	3:1	3:1	--	--	--	--	--	--	--
Aluminum oxide (Al_2O_3)	5	0.5	0.05	0.01	--	--	--	--	--	--	--
Silica (SiO_2)	40	20	5	1	--	--	--	--	--	--	--
Bicarbonate (HCO_3)	50[c]	30[c]	5[c]	0[c]	--	--	--	--	--	--	--
Carbonate (CO_3)	200	100	40	20	--	--	--	--	--	--	--
Hydroxide (OH)	50	40	30	15	--	--	--	--	--	--	--
Oxygen consumed	15	10	4	3	--	--	--	--	8	--	--
Total dissolved solids	--	--	--	--	--	2,500[f]	--	--	--	500	250
Free carbon dioxide (CO_2)	--	--	--	--	20	--	--	--	--	10	10
Sulfide (SO_3)	--	--	--	--	25	--	--	--	--	--	--
5 day BOD	--	--	--	--	--	--	25	--	--	--	--
Corrosion potential	--	--	--	--	--	--	Low as possible	--	--	--	--
Alkalinity (as $CaCO_3$)	--	--	--	--	--	--	--	128 to 135	--	150	75
Heavy metals	--	--	--	--	--	--	--	--	None	--	--
Calcium (Ca)	--	--	--	--	--	--	--	--	10	--	--
Magnesium (Mg)	--	--	--	--	--	--	--	--	5	--	--
Sulfate (SO_4)	--	--	--	--	--	--	--	--	100	--	--
Turbidity (as SiO_2)	--	--	--	--	--	--	--	--	--	50[k]	25[k]
Silica (soluble as SiO_2)	--	--	--	--	--	--	--	--	--	50	20
Calcium hardness (as $CaCO_3$)	--	--	--	--	--	--	--	--	--	--	50
Magnesium hardness (as $CaCO_3$)	--	--	--	--	--	--	--	--	--	--	50
Bicarbonate (as $CaCO_3$)	--	--	--	--	--	--	--	--	200	--	--

a. California State Water Quality Control Board, "Water Quality Criteria", Publication No. 3-A, 1963.
b. Depends on design of boiler.
c. Limits applicable only to feed water entering boiler, not to original supply.
d. Except where odor in live steam would be objectionable.
e. Water considered good enough to drink is considered safe for concrete unless otherwise noted.
f. California State Water Pollution Control Board, "A Survey of Direct Utilization of Waste Waters", Publication No. 12, 1955.
g. Groundwood papers are coarse papers composed primarily of groundwood fibers such as are used for newspapers, telephone directories, cheaper grades of catalogues, and pulp magazines.
h. Pulps produced by chemical cooking processes known as the soda process and the sulfate or kraft process are also called alkaline pulps.
j. Color in platinum units.
k. Materials causing turbidity shall not be gritty.

APPENDIX D

CORRESPONDENCE

COPY COPY

COACHELLA VALLEY ADVISORY PLANNING COMMITTEE

May 27, 1963

Director
Dept. of Water Resources
State of California
Sacramento, California

Dear Sir:

A number of hearings have been held with regard to a proposed Master Plan for sewerage in Coachella Valley. This study, ordered by the Riverside County Planning Commission and made two years ago, does not consider the possibility of the reuse of effluent wastes.

Our organization feels this plan can be improved upon and that when a plan is adopted for the Coachella Valley, it should allow for the possible reuse of all usable water rather than to consign liquid waste directly into drains which run into the Salton Sea.

It is our desire, therefore, that a study to determine the maximum usage of all available water in the Coachella Valley be made by your department at the earliest practicable date.

A Resolution concerning this matter was passed at a recent meeting of the Coachella Valley Advisory Planning Committee and is attached hereto.

Very respectfully yours,

ROBERT S. COX, President
COACHELLA VALLEY
ADVISORY PLANNING COMMITTEE

RSC/mh
Encl.

COPY COPY

COACHELLA VALLEY ADVISORY PLANNING COMMITTEE

Robert Cox, President

P.O. Box 155
La Quinta, California

RESOLUTION

Regarding Need of Valleywide Plan for Water Conservation and Reclamation, and Sewerage

WHEREAS, the Coachella Valley is underlain by high-quality ground waters which are used for domestic, municipal, irrigation, recreation, and other beneficial purposes, and the economy of the Valley is vitally dependent upon the preservation and proper use and reuse of these waters; and

WHEREAS, there is overdraft of this precious water supply, and the rate of overdraft is increasing in accordance with increased development of the Valley, and it is anticipated that in succeeding years such overdraft will reach serious proportions such as to limit the quantity of underground waters; and

WHEREAS, a carefully planned comprehensive, Valley-wide study for optimum use, conservation, and reclamation of Valley waters would be highly beneficial, and particularly so since Coachella Valley still has opportunity to establish and utilize conservation and reclamation measures during this early stage of the Valley's growth; and

WHEREAS, the State Department of Water Resources is authorized to conduct surveys and investigations relating to the reclamation of water from sewage or industrial wastes for beneficial purposes, and the possibilities of use of such water for recharge of underground storage or for agricultural or industrial uses; and

WHEREAS, the Riverside County Planning Commission is the agency of local government which is responsible for comprehensive planning, and has obtained a master sewerage plan for Coachella Valley; and

WHEREAS, optimum beneficial use and reuse of waters of the Valley require the incorporation of sewerage plans as an integral part of reclamation; now therefore be it

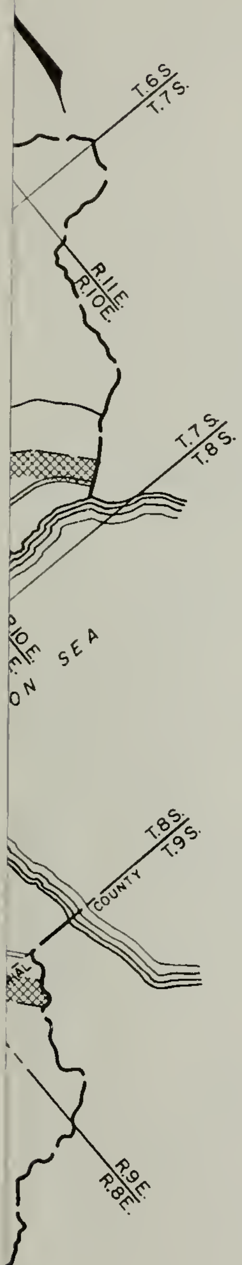
RESOLVED, that the Coachella Valley Advisory Planning Committee hereby requests the services of the State Department of Water Resources in the conduct of surveys and investigations relating to basin-wide water reclamation and reuse, and that such surveys and investigations be conducted at the earliest possible date;

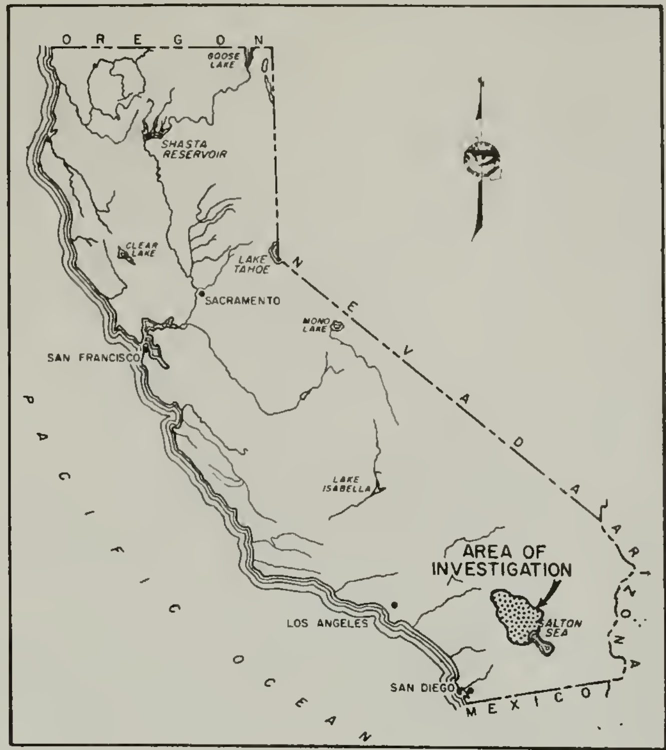
BE IT FURTHER RESOLVED, that copies of this resolution be forwarded to the Riverside County Board of Supervisors, the Riverside County Planning Commission, and other interested agencies, requesting that they adopt a similar resolution, and send a copy to the Director of the State Department of Water Resources;

BE IT FURTHER RESOLVED, that the Coachella Valley Advisory Planning Committee requests that the Riverside County Planning Commission withhold further action upon the present Report and Master Sewerage Plan, until it is possible to determine the correlation which may exist between feasible water reclamation and reuse plans and such master sewerage plan;

BE IT FURTHER RESOLVED, that copies of this resolution be forwarded to the Director of the State Department of Water Resources, to the District Engineer of the State Department of Water Resources, Southern District, Los Angeles, and to such other persons and agencies who may have need therefor, and who may request same.


LITTLE SAN BERNARDINO MOUNTAINS
SAN BERNARDINO MTS
SAN JACINTO MOUNTAINS
SANTA ROSA MOUNTAINS
MECCA HILLS
SALTON SEA
WHITEWATER RIVER
DILLON ROAD
COACHELLA CANAL
SAN BERNARDINO COUNTY
RIVERSIDE COUNTY
SAN DIEGO COUNTY
FARGO CANYON
SKY VALLEY
MIRACLE HILL
THOUSAND PALMS
DESERT HOT SPRINGS
MISSION CREEK
NORTH PALM SPRINGS
GARNET HILL
WHITEWATER
PALM SPRINGS
TAHQUITZ CREEK
SNOW CREEK
SAN GORGONIO RIVER
SAN GORGONIO PASS
CABAZON
BANNING
CATHEDRAL CITY
PALM DESERT
PALM CITY
LA QUINTA
INDIO
COACHELLA
THERMAL
MECCA
OASIS
LOCATION MAP
OREGON
NEVADA
ARIZONA
MEXICO
PACIFIC OCEAN
SACRAMENTO
SAN FRANCISCO
LOS ANGELES
SAN DIEGO
AREA OF INVESTIGATION
LEGEND
SURFACE WATER SAMPLING STATION
WELL SAMPLING STATION
WASTE WATER DISPOSAL PLANT
APPROXIMATE BOUNDARY OF SEMIPERCHED GROUND WATER TABLE
BOUNDARY OF INVESTIGATIONAL AREA
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT
RECLAMATION OF WATER FROM WASTES
IN COACHELLA VALLEY
LOCATION OF WATER SAMPLING POINTS
AND WASTE WATER DISPOSAL SYSTEMS
SCALE OF MILES
1965





LOCATION MAP

LEGEND

- POTENTIAL AND EXISTING IRRIGATION USES.
- POTENTIAL WASTE WATER RECLAMATION PLANT
- EXISTING WASTE WATER RECLAMATION PLANT
- POTENTIAL GROUNDWATER RECHARGE
- APPROXIMATE BOUNDARY OF SEMIPERCHED GROUND WATER TABLE
- BOUNDARY OF INVESTIGATIONAL AREA

C C COUNTRY CLUB

G C GOLF COURSE

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT

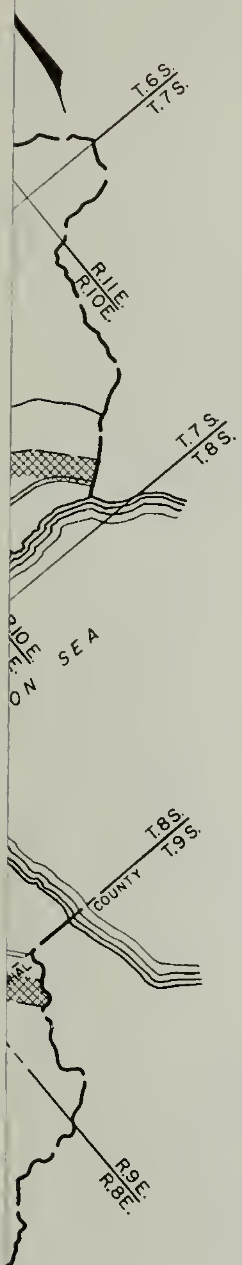
RECLAMATION OF WATER FROM WASTES
IN COCHELLA VALLEY

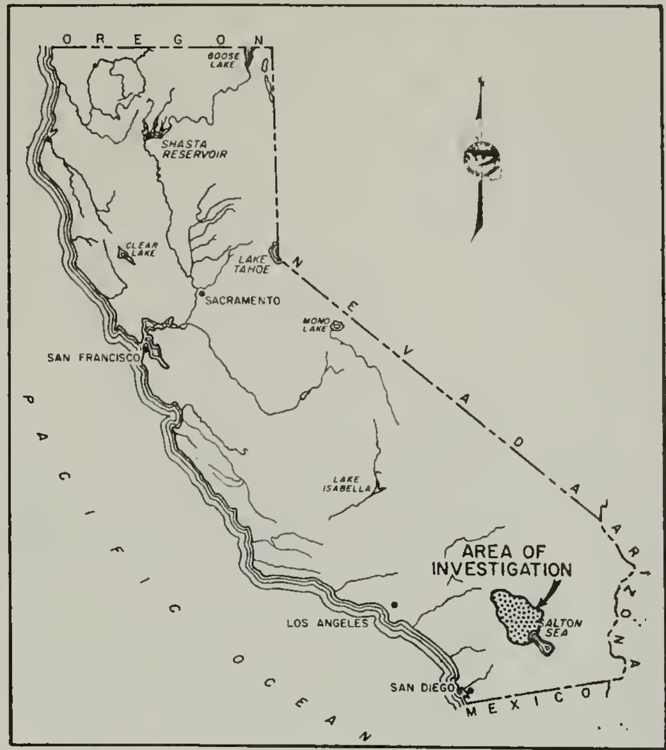
WASTE WATER RECLAMATION PLANTS, LOCATION AND POTENTIAL USES

SCALE OF MILES

1 0 1 3 5 7

1965





LOCATION MAP

LEGEND

- POTENTIAL AND EXISTING IRRIGATION USES
- POTENTIAL WASTE WATER RECLAMATION PLANT
- EXISTING WASTE WATER RECLAMATION PLANT
- POTENTIAL GROUNDWATER RECHARGE
- APPROXIMATE BOUNDARY OF SEMIPERCHED GROUND WATER TABLE
- BOUNDARY OF INVESTIGATIONAL AREA

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SOUTHERN DISTRICT

RECLAMATION OF WATER FROM WASTES
IN COCHELLA VALLEY

WASTE WATER RECLAMATION PLANTS, LOCATION AND POTENTIAL USES

SCALE OF MILES

1 0 1 3 5 7

1965

LOCATION MAP

LEGEND

- POTENTIAL AND EXISTING IRRIGATION USE
- POTENTIAL WASTE WATER RECLAMATION PLANT
- EXISTING WASTE WATER RECLAMATION PLANT
- POTENTIAL GROUNDWATER RECHARGE
- APPROXIMATE BOUNDARY OF SEMIPERCHED GROUND WATER TABLE
- BOUNDARY OF INVESTIGATIONAL AREA

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DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT

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IN COCHELLA VALLEY

WASTE WATER RECLAMATION PLANTS, LOCATION AND POTENTIAL USES

SCALE OF MILES
0 3 5 7

1965

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